University of Alberta

The Economic Impacts of Chronic Wasting Disease on Hunting in Alberta:
A Multi-Year Study

by

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For Hannah, Mary Ann, and Lorne who love and support helps me through anything and everything.

Abstract

This study has attempted to measure the economic impacts of chronic wasting disease (CWD) on Alberta hunters, in the study region of the Eastern to South-Eastern border of the province. Two years of stated preference and revealed preference data were collected and choice behaviour modelled using logit and nested logit methods which included attributes such as CWD prevalence, culling of herds, and the provision of extra tags. Multi-year models found that hunters from the second year were more satisfied with culling than hunters from the first year, while hunters from the second year were more negatively affected by the provision of tags and the prevalence of CWD relative to hunters from the first year. Hunters were also found to be more systematic in their hunting site choices in year 1 relative to year 2.

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Chapter 1 – Introduction

Chronic Wasting Disease (CWD) is a cervid prion disease, which affects mainly deer populations. CWD is similar to the prion disease, Bovine Spongiform Encephalopathy (BSE), or, "mad-cow disease". CWD is found within many areas of North America; however, within Canada, it has only been detected in Alberta and Saskatchewan thus far. Both wild and farmed deer populations in Alberta have had CWD diagnoses (Government of Alberta Agriculture and Rural Development website). The implications of CWD are diverse, from the effect it has on the infected animal, nature, and the people who utilize the land and wildlife within these areas. This study will examine the impact of CWD on recreational hunting over a two-year period in Alberta, and provide follow up on an earlier study that examined the first year of the data utilized in this study (Zimmer 2009).

A. <u>Chronic Wasting Disease</u>

Prusiner has defined the term prion as "proteinaceous infectious particles that lack nucleic acid" (1997 p250). Prions can appear sporadically, be dominantly inherited, or acquired through infection; regardless of the type of prion disease, they all involve conversion of normal cellular protein into the abnormal disease causing isoform, where α-helical content diminishes and the amount of β-sheets increase (Prusiner 1997 p245). This leads to cellular damage, and therefore, tissue damage, which is invariably fatal "manifest[ing] a spongiform appearance as a result of the destruction of brain tissue" (Ryou 2007 p1061). The central nervous system is a major target for prions; however, "small amount of prions are replicated and accumulated in the secondary lymphoid organs and tissues in the periphery", long before it appears in the brain (Ryou 2007 p1062). Interestingly, unlike bacterial and viral infections, there is no inflammatory response to prions or generation of anti-prion antibodies in the infected individual (Ryou 2007 p1061).

CWD is a cervid prion disease, affecting those within the deer family, which includes deer, elk, moose, and caribou. It has currently been identified within deer and elk populations; there is fear of CWD crossing into moose and caribou populations. According to Happ et al. (2007 p224), the caribou "prion alleles are identical or nearly so to those of wapiti, white-tailed deer, and mule deer" and the genetic evidence seems to be capable of "permit[ting] the spread of chronic wasting disease from middle-latitude deer to high-latitude caribou in North America". Should CWD cross into caribou species, many of which are experiencing declining populations (Government of Alberta SRD website *Caribou Management*), there could be potentially devastating ecological and socioeconomic consequences.

The precise mode of transmission of CWD is not yet know; however, it "transmits laterally at a highly efficient rate that has never been observed in any other prion diseases" (Ryou 2007 p1060). According to Conner et al., transmission has been shown to occur through direct animal-to-animal contact, potentially through saliva, and "through indirect environmental contamination from pathways that include excreta and carcasses" (2008 p156). There remains concern, despite a lack of evidence, that CWD could be transmitted to humans, threatening public health, similarly to the British BSE outbreak (Ryou 2007 p1060). There is also concern that CWD could cross the livestock barrier. Presently, cattle who have been "intensively exposed to CWD-infected deer and elk" managed to remain healthy (Conner et al. 2008 p155). Alternatively, research has shown that "cattle have become infected with CWD via cerebral inoculation with material from diseased mule deer and white-tailed deer"; however, with such transmission is not possible in a natural setting, it does show the potential for transmission exists (Conner et al. 2008 p155).

A challenge with CWD is that there is no specific clinical diagnostic feature in the early and mid-phase of the disease (Williams 2005 p531). Positive identification of CWD in an individual is currently performed after death through sampling lymph nodes and neural tissue (Zimmer 2009 p2). According to Conner et al., there is a promising new sampling technique to identify CWD using "antemortem rectal mucosa-associated lymphatic tissue", this appears to be less expensive than traditional antemortem testing while also suitable for rapid testing (2008 p160).

Signs and symptoms of CWD are similar to cattle with BSE or sheep with scrapie. Williams (2005 p531) describes the most outstanding signs of a CWD infected individual being "weight loss and behavioural changes that typically span weeks or months". However, additional symptoms include excessive salivation, grinding of teeth, lowering of the head, repetitive walking patterns, ataxia, excessive thirst and urination, hyper-excitability, and altered interactions with herd-mates and handlers (Williams 2005 p531). It is also worth noting that CWD is not seasonally dependent, individuals can become infected at any time of year (Williams 2005 p532). While there exists a number of unknowns surrounding CWD, there are identifiable impacts of CWD on human/hunter wellbeing and economic activity through hunting.

B. Hunter Behaviour and the Impact of Changing Levels of CWD

Over time, the number of wildlife certificates and hunting licences in Alberta has declined, however, deer licence sales and big game hunters have increased (Watson and Boxall 2005). Given the importance of the economic impact of hunting, especially in rural Alberta, and the increase in deer hunting licences and big game hunters, it is important to study hunter behaviour and the resulting impact of CWD in an economic framework. Hunting values are non-market in nature; therefore, the economic benefits of CWD management must be assessed using non-market valuation techniques. These values depend on the behavioural model structure and the accuracy of the representation of behaviour. While most recreation demand studies are single year in nature, which does not allow for the opportunity to examine changing preferences/perceptions, learning, or other factors;, this study utilizes multi-year data and the opportunity to assess changes overtime. This may be an important factor in the case of an emerging quality change or potential health risk.

There have been a number of studies regarding the human dimensions of CWD; however, there have been few studies done with an economic analysis of CWD. Bishop was the first to attempt economic analysis of CWD; he followed his work from 2002 up with a more rigorous study, again in Wisconsin, 2004. Bishop described his 2004 article as more of an attempt to predict who had been affected by CWD and to consider potential magnitudes of the various hunting related impacts of CWD (Bishop 2004 p182). Bishop (2004) calculated an estimate of the loss in consumer surplus and determined an estimate of economic losses for 2002 and 2003. Bishop acknowledged that his estimates were not overly precise because his calculations were made using what data was available and what were considered reasonable assumptions. While hunting was not a large part of the Wisconsin economy, it had the potential to generate large regional economic imbalances.

Zimmer's (2009) thesis, "The Economic Impacts of Chronic Wasting Disease on Hunting in Alberta" is the only other known study that looks into the economic effects of CWD in Alberta. Her work focused on the study region along the Eastern to South-Eastern boarder of Alberta. Her study incorporated the evaluation of the benefits of CWD management strategies, their effectiveness and measured the resulting costs. She modelled hunter site choice behaviour and found that hunters were negatively affected by CWD and the culling of herds while positively affected by the provision of extra tags. Her data also allowed her to calculate economic welfare measures for avoiding a high prevalence of CWD.

There continues to be a need for improved benefit measures in the context of changing CWD levels and potentially to changing risk perceptions over time. This study addresses hunter response to CWD over time and changing CWD conditions using survey data from hunters who participated in the 2007 and 2008 hunting seasons. The study region is the same one used by Zimmer in 2009.

C. <u>Hunting in Alberta and the Resulting Economic Impact</u>

To date, in Canada, CWD has been detected in Alberta and Saskatchewan. The Alberta Government began a voluntary CWD surveillance programme in 1996, becoming mandatory in 2002, coinciding with the first confirmed case of CWD in a farmed elk. The Government of Alberta's Fish and Wildlife Division began a herd reduction programme in 2005, in a sample area, which was designed to reduce deer density and control the spread of CWD. By early 2006, the herd reduction program, accomplished through culling, was extended to include areas within the surrounding areas of infected deer. The Alberta Government had also increased the provision of tags to hunters who submitted harvested deer heads for testing; eventually, having made head submission mandatory for any deer killed within an infected area and voluntary for surrounding areas. Finally, the Alberta Government implemented the removal of deer within a 10 kilometre distance of where an infected animal was discovered.

From 2007 to 2008, the Alberta Government implemented a fall hunter surveillance program along with a winter control program. The winter control program was subsequently discontinued in January 2009, despite the increasing CWD prevalence and distribution among fall hunter surveillance (Government of Alberta SRD website *CWD History in Alberta*). This demonstrates the need for more information on the benefits, costs, and effectiveness of management programs. This study will attempt to measure the benefit estimates for the study region over the 2007 and 2008 hunting seasons.

The results of Zimmer's study suggest that the economic impact of CWD may be substantial; however, it is important to examine this impact over time to assess the longer term implications of CWD. Information available has changed over time and hunter perceptions may have also changed. Potential risks associated with CWD, whether human or wildlife may drive out hunters from the sport and individuals involved in related industries, resulting is substantially decreased expenditures and economic activity. Thus, in order to more accurately evaluate the economic impact of CWD management programs, more detailed assessment of hunter responses are required.

This study focuses on Wildlife Management Units (WMUs) along the border of Alberta and Saskatchewan, which was where cases of CWD in Alberta were found during the time of the study. As of March 2011, there have been 85 mule deer and 9 white-tailed deer positively identified as having been infected with CWD. At the time of the study, WMUs 150, 151, 163, 234, and 236 were identified as CWD infected zones. More recently however, the disease appears to be spreading, and has been detected in WMUs 728, 152, 256, 200, 202, and 119 (Government of Alberta SRD website *Statistics: Chronic Wasting Disease in Wild Deer*). With changing CWD prevalence levels and spread it is important to examine overtime if hunters change where they typically hunt due to CWD, how hunters react to management practices and the prevalence of CWD, and the overall effect on hunting in Alberta.

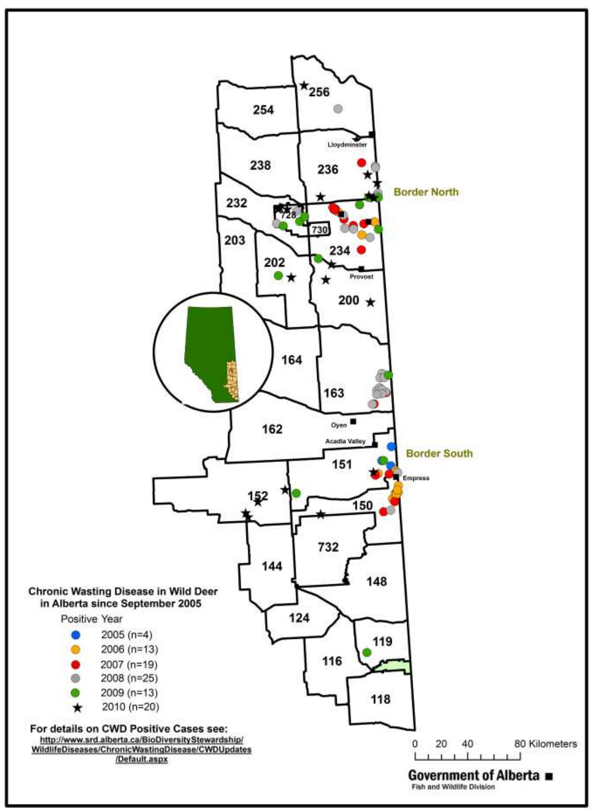

Figure 1-1. Map of Alberta CWD surveillance identified zones.
Map taken from:
http://www.srd.alberta.ca/BioDiversityStewardship/WildlifeDiseases/ChronicWastingDisease/CWDUpdates/Default.aspx

D. Study Plan

This study attempts to determine the economic value of the impacts created by CWD and its related management in the context of changing CWD levels and risk perceptions over time. An internet survey was designed to obtain the behavioural changes of deer hunters based on the spread and prevalence of CWD and the various management practices aimed at controlling the disease. Using the data from the questionnaires implemented in both 2007 and 2008, actual previous hunting trips and hypothetical hunting trips will be used to determine hunter demographics, attitudes, preferences, and calculate the resulting economic impacts. The multi-year data will be examined to investigate preference/perception change and the potential for change in error variance overtime. The multi-year data can help produce a better behavioural model which should result in a more accurate estimate of the economic impact of CWD.

The following chapter will provide background regarding previous CWD studies from biological, sociological, and economic perspectives followed by relevant recreation demand theory. Chapter 3 will describe the model and the theory used for this study, which includes the travel cost model, random utility models, and the nested logit model. Also included will be a discussion of modelling welfare impacts and data used for discrete choice analysis. Chapter 4 will explain the questionnaires used in 2007 and 2008, an account of the data collected, and noteworthy descriptive statistics. Chapter 5 will present the results of the study, with basic behavioural models being presented first followed by the more complex models. Results from the 2008 data will be presented first, beginning with the revealed preference models, stated preference models, and finally the joint revealed and stated preference models. The 2008 results will be compared to the 2007 results. The final models presented will consist of the multi-year data. The resulting welfare and economic analysis will be presented at the end of chapter 5. Finally, chapter 6 will provide a summary of the study along with conclusions, applications to management, and future research.

Chapter 2 – Background

A. <u>Previous CWD Studies</u>

There has been extensive research regarding the CWD prion, with a wide range of topics from within the natural sciences. On the other hand, the social science literature has mainly focused on the sociological implications of CWD with relatively little research into economic impacts. This chapter will briefly review the CWD literature and the recreation demand literature.

<u>a. Overview</u>

i. Biology of CWD

As mentioned in Chapter 1, "prions are pathogens that accumulate in the central nervous system (CNS) and cause fatal neurodegeneration" (Tamguney et al. 2006 p9104). Prions are known to affect both humans and livestock (including cattle, sheep, and goats), as well as deer and elk (both captive and wild). There have been a number of confirmed cases where bovine spongiform encephalopathy (BSE) from cattle, which was transmitted to humans through tainted meat, who, subsequently died of variant Creutzfeldt-Jakob disease (Tamguney et al. 2006 p9104). It has been this transmission of BSE to humans which has raised concern about the possible transmission of CWD to humans. Though there has been no evidence of transmission to humans, it cannot be ruled out. CWD has shown incredible "resistance to environmental conditions and a range of treatments such as heat, most disinfectants, and ionizing and ultraviolet radiation" (Williams et al. 2002 p554). There has also been concern regarding CWD crossing the livestock barrier to infect cattle, however, research has shown that cattle which have been in confinement with CWD infected deer or intensively exposed to CWD infected deer remained healthy (Conner et al. 2008 p155). It has been shown, however, that “many species are experimentally susceptible to CWD (as well as other TSEs) when exposed via cerebral inoculation” (Williams et al. 2002 p555). A more recent study by Race et al. inoculated two nonhuman primate species through oral and intracerebral routes; the squirrel monkeys largely developed clinical wasting syndrome, where as the cynomolgus macaques had not after 70 months post infection. This study showed how species differ in their susceptibility to CWD. However, since “humans are evolutionarily closer to cynomolgus macaques than to squirrel monkeys, they may also be resistant to CWD” (Race et al. 2009 p1366). Through studies of this nature, evidence of the risk of CWD transmission to humans is considered to be negligible; however, hunter behaviour could be potentially altered when presented with situations that involve CWD. Therefore, examination of CWD perceptions continues to be important to analyze and gain understanding into CWD’s ramifications.

ii. Human Dimensions of CWD

In 2002, Williams et al. described within their paper, “Chronic Wasting Disease of Deer and Elk: A Review with Recommendations for Management”, the pathogenesis and epidemiology of CWD and proceeded to make recommendations for management strategies. Some of these strategies included monitoring areas where the disease has not been known to occur and development of “surveillance programs and regulations that prevent or reduce the likelihood that CWD will be introduced into their jurisdiction” (Williams et al. 2002 p551). To date, there has not been an effective treatment for cervids infected with CWD and it is inevitably fatal. Control strategies, therefore, have been the only method for dealing with infection so far; however, the various control strategies are problematic at best. Controlling CWD in farmed cervids has its unique challenges, which will not be examined here, as this study has focused on hunting. Controlling for CWD in wild cervids has presented even larger challenges. There have been long-term active surveillance programs to “monitor CWD distribution and prevalence” (Williams et al. 2002 p559) in an effort to assess the disease, evaluate changes over time, and the efficacy of intervention management. Attempts to contain CWD and/or reduce prevalence in localized areas include banning artificial feeding and culling. These programs are expensive and detract from other wildlife management needs. Overall, of the programs that have been established, the efficacy has yet to be determined (Williams et al.2002 p560).

In 2004, the journal *Human Dimensions of Wildlife* produced a special issue specifically addressing a variety of issues surrounding management and control of CWD. Heberlein (2004) discussed how the discovery of three free ranging deer infected with CWD in Wisconsin in February 2002 was treated as if it were an emergency, likened to that of a fire which moves rapidly, by the

Wisconsin Department of Natural Resources. The actions taken by the Wisconsin Department of Natural Resources, such as poorly defining key stakeholders and their concerns, while also ignoring the current research at the time, resulted in the biological and social goals not being achieved and, in some instances had an effect opposite to that intended by the management agencies. Hunters were killing fewer deer, deer hunting licence sales declined, and deer densities had remained high. This represented a very large "decline in the annual surplus value of deer hunting in the state" (Heberlein 2004 p165).

In 2003, Petchenik, from the Wisconsin Department of Natural Resources, published "Chronic Wasting Disease in Wisconsin and the 2002 Hunting Season: Gun Deer Hunters' First Response". It was the first study to examine the actual or potential social and economic impacts of CWD through analyzing hunters' response to the disease. He gathered data by administering a mail survey at the end of the 2002 hunting season to a random sample of hunters from the 2001 database of licensed gun deer hunters with a response rate of 68%. From this, it was discovered that hunter behaviour had remained constant, despite the concern and controversy surrounding CWD, and most had the deer meat processed for human consumption. Most hunters believed that the Wisconsin Department of Natural Resources provided truthful information and should continue monitoring for CWD but wait for test results before implementing disease management programs; however, the respondents largely did not trust the Department to make good CWD management decisions.

Vaske et al. (2004) examined the extent to which CWD influenced deer hunters from the 2001 hunting season would not participate in the 2002 season, while also comparing deer hunters from the 2002 season to those who did not participate. The data used in this study were from Petchenik's 2003 publication. The study done by Vaske et al.(2004) used cluster analysis of potential reasons why hunters had dropped out of the 2002 hunting season suggested that approximately half of hunters from 2001 who chose to not hunt in 2002 did so because of CWD. Vaske et al. (2004) concluded that of the approximately 11% decline in deer hunting licences sold, approximately half of the decline was due to CWD, whereas, Petchenik had postulated, through factor analysis, that approximately one third of the decline in licence sales was due to CWD. Other than this discrepancy, Vakse et al. (2004) and Petchenik (2003) had similar results. Vaske et al. (2004) also discovered that those who chose to participate in the 2002 gun hunting season and those who dropped out of the 2002 hunting season for reasons not related to CWD had statistically significant responses regarding perceived CWD risks and trust in the Wisconsin Department of Natural Resources. Hunters who dropped out of the 2002 hunting season for CWD reasons were "less likely to believe the information provided by the WDNR and were less trusting of this agency compared to those who hunted" (Vaske et. al. 2004 p194).

Miller's (2004) paper "Deer Hunter Participation and Chronic Wasting Disease in Illinois: An Assessment at Time Zero" explored hunter response to the discovery of a single case of CWD near the Wisconsin border in 2002 two weeks before the firearm deer season. He reports the 2003 results of a mail survey sent to a random sample of deer hunters; specifically to examine the impact of CWD on hunter attitudes and behaviour. Overall, he found that 89% of deer hunters participated in the firearm deer season with approximately 82% hunting as usual. However, approximately 14% of respondents from CWD counties reported that they did not participate in the 2002 firearm deer season. Slightly over half of respondents felt that there was uncertainty surrounding the potential of humans contracting CWD, while 17% of respondents thought that CWD could potentially transmitted to humans through the consumption of infected animal meat. In the end, hunters did not anticipate any change in their hunting behaviour for 2003; however, they did express an increased level of caution should CWD be found in a county next to where they typically hunt. Miller suggested that this represented a baseline for hunter behaviour in Illinois and that as CWD expands within the state, that hunter attitudes and behaviours be monitored to detect changes, as hunter response could change drastically.

Needham et al. (2004) conducted a study which included eight states which focused on hunter behaviour and hunter acceptance of management practices and strategies for managing CWD. The authors were interested in examining hunter behaviour and acceptance under higher rates of wild herd infection, since there had been a number of studies done regarding the relatively low rate of infection that was current at the time of publication. Needham et al.

(2004) utilized computer generated maps which showed various levels of CWD human health impacts with increased prevalence and spread of CWD among deer and elk. This was presented to hunters in a mail-out survey. Results indicated that an overall 5% decrease in hunting was due to CWD at current levels of infection, which was consistent with previous studies, which suggests that there would be continued hunting even with the presences of CWD. Needham et al. (2004) discovered that at higher levels of infection, there would be a significant impact on hunting. In general, when scenarios with higher levels of infection were presented, it was largely deemed unacceptable by the respondents for the government agencies to ‘take no action’, while CWD testing and dramatic deer herd reduction were accepted by a majority of hunters. Needham et al. (2004) used logistic regression to determine the probability of hunting under various scenarios, however, there was no economic analysis presented.

In 2006, *Human Dimensions of Wildlife* produced another issue devoted to CWD which explored in more depth issues relating to communication, information, and various other stakeholders. Decker et al.’s (2006) article “Wildlife Disease Management: A Manager’s Model” postulated a wildlife disease management model which was based on previous studies regarding the conclusions and effectiveness of CWD management.

Needham et al. (2006) expanded on their 2004 article, with a more comprehensive data set, which allowed for comparison across states. They examined how CWD may influence hunters to hunt in different states or abandon hunting altogether, how hunters respond to both lethal and non-lethal disease management strategies and to determine whether hunter response varied by the state in which they hunt, the state the hunter resides in, and the species hunted. Overall, the conclusions from this study were much like that of their previous study in 2004; however, because hunter response was largely similar across each state, Needham et al. (2006) identified disease management as a regional problem rather than a state level problem.

Over the two years that passed between these two special issues regarding CWD, CWD spread to new states. CWD had reached the state of New York in 2005 and was first found in farmed deer shortly followed by the discovery of CWD in wild deer herds. Brown et al. (2006) examined the response of the newly infected state. Their study focused on hunter and general public response to CWD and their information seeking behaviour and related trust in information sources. Brown et al. (2006) found that hunters were more familiar with CWD than the general public was. Respondents in this study felt that government agencies were trusted sources of information about CWD and related consequences. Brown et al. suggested "filling an information void during the early stages of public exposure to CWD when public demand for information is high may be a critical intervention to affect risk perception" (2006 p214), where information could be provided both as traditional media, such as newspapers, and at the same time in a more modern media format such as the internet to maximize information distribution.

Vaske et al. (2006a) extended the research on CWD information sources and knowledge of hunters and non-hunters in the states of Colorado and Wisconsin: states where the disease had been present for a longer period of time. A survey of Colorado and Wisconsin hunters and non-hunters revealed that a majority of respondents when presented with true/false questions regarding CWD, answered half or less questions correctly. Vaske et al. (2006a) determined that the more effective sources for improving Wisconsin hunter knowledge were the Wisconsin Department of Natural Resources website, Wisconsin Department of Natural Resources secretary column, and local newspapers; while the best sources of information for Colorado hunters included the Colorado Division of Wildlife website and a hunting regulations brochure. The only source of information that improved Wisconsin non-hunter knowledge of CWD was the Wisconsin Department of Natural Resources newsletter. Heberlein (2004) suggested that the "actions taken by the media and WDNR have been referred to as rapid, extreme, and aggressive, and have been partially blamed for the decline in deer hunting following discovery of CWD in the state" (Vaske et al. 2006a p199), which shows how important media is in conveying information regarding CWD.

Furthering the research on information sources and CWD, Eschenfelder (2006) published "What Information Should State Wildlife Agencies Provide on

Their CWD Websites?". Here Eschenfelder (2006) performed an information analysis of four state CWD websites to examine what information was posted and areas where information was lacking. She discovered that, of the four state CWD websites studied, many were publishing information directed towards private citizens, which "assumes policy decisions are made by agency experts with limited or no input from citizens" (Eschenfelder 2006 p221), regarding "whether to hunt, where to hunt, and how to handle carcases" (Eschenfelder 2006 p222). She found that only Colorado and Wisconsin were providing attentive citizen information, which "assumes decisions are made by agency experts who may or may not be informed by stakeholder input" (Eschenfelder 2006 p221). When information is conveyed in this manner it allows the public to review agency decisions, plans, actions, and ensures citizens can judge policy outcomes. Colorado and Wisconsin provided "management plans, external program reviews, and references to scientific publications used in agency decision making" (Eschenfelder 2006 p222). Overall, conclusions made by Vaske et al. (2004) were similar to that of Eschenfelder (2006).

Vaske et al. (2006b) describe a formula, and graphical representation, for computing a Potential for Conflict Index (PCI) in their paper "Potential for Conflict Index: Hunters' Responses to Chronic Wasting Disease" to help communicate research results to managers. The data used were those of Petchenik (2003) and Vaske et al. (2004), however, geographical techniques were used in this particular study to present results to managers. This method facilitated transmission of statistical information and conveyed implications of hunter behaviour and hunter attitudes towards management decisions. Vaske et al. (2006b) found that the Potential for Conflict Index (PCI) was able to assist managers in their understanding of similarities and differences between hunting groups and related behaviours; however, the authors acknowledge that more robust statistical analysis would increase the credibility of the PCI.

Management strategies' regarding CWD has involved the notion of controlling the disease through various programs that induce deer population reduction amidst increased CWD testing. Hunters have long been employed as an instrument for population control for wildlife such as deer and elk, however it has become especially complicated in areas where drastic herd reduction has been indicated as a means for limiting the spread of disease. Hunter behaviour, attitudes, and response to management programs were explored by Holsman and Petchenik (2006) through identifying hunter type, harvest efficiency, and predominant attitudes of a random sample of resident gun-deer hunters during the 2004 hunting season. They used logistic and linear regressions to determine the influence of various attitudinal variables and attributes of hunting experiences on the number of deer harvested. Overall, they discovered that programs that provided extra tags once an antlerless deer was harvested were primarily effective at the lower end of the harvest distribution, while other reward programs, predominantly monetary, were ineffective. Holsman and Petchenik (2006) determined that the use of hunters as an effective instrument to drastically reduce deer herd populations has not proven to be particularly effective.

Also in 2006, Petchenik published a study that examined Wisconsin landowner response to CWD. He obtained his data through a mail survey sent to a random sample of landowners in Wisconsin's southwest Disease Eradication Zone (DEZ). Landowners and the state had similar attitudes towards the goals regarding CWD, such as, containment and eradication. This study found that landowners who were also hunters "were more likely to be aware of four incentives intended to promote more deer harvest than landowners who do not hunt" (Petchenik 2006 p225). Petchenik found that additional tags and a longer hunting season were significant factors in a hunter's decision to spend more time hunting while monetary incentives were not sufficient; however, approximately one third of hunter landowners indicated that none of the incentives had an impact on their behaviour. These results were consistent with the preceding study by Holsman and Petchenik (2006).

Stafford et al. (2007) used the same data set as Petchenik (2006) to examine the differences in beliefs regarding CWD and related management of landowners who hunt and landowners who do not hunt. Stafford et al. (2007) found that hunters vs. non-hunters differed on 5 of the 6 belief indices, while both groups were mainly neutral regarding their trust of the Wisconsin Department of Natural Resources. They used cluster analysis to show that non-hunting landowners were largely not concerned about CWD and its management; however, most hunting landowners were concerned about CWD and its management. With these results, Stafford et al. (2007) suggested that when such a large portion of the population was essentially indifferent towards CWD and its management, there was significant potential for problems regarding the management of CWD. To mitigate this, they recommended that managers improve communication efforts to increase awareness about CWD, alleviate concerns about the disease, and increase stakeholder input related to CWD to help increase stakeholder trust in Department of Natural Resources.

Needham et al. (2007) examined hunter response to various scenarios of CWD. They took a fresh approach to interpret hunter response by dividing deer and elk hunters from eight states by resident or non-resident hunter, respondents were then further subdivided among these two groups by their level of hunting specialization: casual, intermediate, focused, or veteran. Respondents were given hypothetical scenarios with various CWD prevalence levels and human deaths related to CWD then they were asked their response to the situation. The results were fairly pronounced, Needham et al. (2007) found that with worse CWD conditions, approximately 46% of non-resident hunters would be more likely to switch the state in which they hunt while approximately 38% of resident hunters would simply quit hunting. Of resident and non-resident hunters, casual hunters were most likely to quit while veteran hunters were least likely to quit. This result could potentially have a dramatic implication for future deer and elk hunting, when CWD has a greater influence among new comers to quit the sport; however, since casual hunters are the minority, the impact on future hunting may not be too drastic.

Needham and Vaske (2008) explored hunter perceived risk associated with CWD and “the influence of perceived similarity and trust in state wildlife agencies as determinants of risk” (Needham and Vaske 2008 p197), using the data from Needham et al. (2004). They found support for both hypotheses that they tested within this paper. The first hypothesis was that a positive relationship exists between perceived similarity and social trust while the second hypothesis was that a negative relationship exists between personal risk and social trust. Needham and Vaske (2008) quantified that hunter perception of similarity with that of wildlife agencies positively influenced trust in these agencies to manage CWD, which explained approximately 49% of variance in trust, while trust explained approximately 8% of the variance in risk where hunters trusted agencies and perceived less risk. These results were consistent with previous literature, such as Vaske et al. (2004) where they determined that personal risk had a profound impact on hunting decline.

Again, in 2010, *Human Dimensions of Wildlife* put forth another special issue devoted to the topic of CWD, acknowledging that one of the most challenging parts to CWD management has been the human component, because hunters have not necessarily responded to incentive mechanisms as they were intended. This issue illustrated the development of literature and research in wildlife management relating to CWD since the last special issue in 2006.

Holsman et al. (2010) discussed six primary reasons why hunters in Wisconsin resisted the efforts of the wildlife management of CWD. They analyzed a dozen surveys of deer hunters and landowners to extract the "six psychological bases that deer hunter opposition to the Wisconsin plan" (Holsman et al. 2010 p180). Generally, hunters indicated that they supported stopping CWD and that the Wisconsin Department of Natural Resources ought to implement some CWD management plan; however, hunters strongly opposed radical deer density reduction and did not appear to be a logical approach. Traditionally, bow hunters had almost two months prior to the opening of firearm season, which was coveted by bow hunters because it gave them access to increased rutting buck activity, "the new CWD firearm season interfered with the exclusive opportunity of archers to hunt rutting bucks" (Holsman et al. 2010 p185). Hunting as disease management was also in direct conflict with the social norm among Wisconsin deer hunters who traditionally have hunted for personal consumption. In addition, hunter concern regarding CWD appears to have decreased since 2002 when CWD was discovered, likely because hunters were responding to media bombardment, which focused on links to mad-cow disease and Creutzfeldt-Jakob disease. Finally, the Wisconsin Department of Natural Resources lacked credibility and scientific research to support their CWD eradication plan. Conclusions from Holsman et al. (2010) demonstrated that recreational hunting as a tool to manage CWD has proven ineffective to achieve significant herd reduction and that other methods, such as trap/test/cull would be required,. However, these alternatives may be cost prohibitive.

Cooney and Holsman's (2010) article examined the influence of risk perception and beliefs of deer hunter support for deer herd density reduction as a strategy to combat CWD in Wisconsin. It was found that the influence of risk perception of hunter support for density reduction goals depended on beliefs regarding the extent to which eradication was necessary. Risk perception likely influenced hunter support in the overall goal to reduce deer density. This effect was dampened when hunters expressed concern and uncertainty regarding deer herd reduction as a means of generating the desired outcome of CWD eradication, when presumably higher deer herd densities would be more desirable because "seeing [deer] is one of highest rated influences on deer hunter satisfaction" (Cooney and Holsman 2010 p195). These results imply that "hunter beliefs about the likelihood of deer reduction achieving CWD eradication had the greatest influence on support for herd reduction" (Cooney and Holsman 2010 p194). Cooney and Holsman (2010) suggest that significant evidence would be required, to show that herd reduction is linked to decreasing spread or eliminating CWD, and to increase hunter beliefs in the effectiveness of such a strategy if managers wish to utilize recreational hunters to manage CWD.

Lyon and Vaske (2010) examined four states and factors related and unrelated to CWD, which had influenced hunters to cease hunting deer. A survey of resident and non-resident deer hunters presented six hypothetical scenarios with increasing CWD prevalence and human impact, where the hunters were asked if they would continue or stop hunting deer in the state. They used logistic regression to determine the influence of four predictor variables, which included prevalence, human impact, perceived risks from CWD, and location of hunting participation. Analysis showed that “human impact and perceived risks had the largest effect on hunter behavior” (Lyon and Vaske 2010 p208). They concluded that deer hunting participation would decline considerably should CWD prevalence increase significantly, with the greatest decline occurring when human death was combined with high CWD prevalence rates.

Lischka et al. (2010) examined resident knowledge and support of actions attempting to control CWD within the infected area in Illinois after five years of implementation. A random sample of residents within CWD positive or adjacent counties were surveyed, where 47% of those contacted responded to the survey. When asked about CWD in Illinois, general respondents (49%) were significantly less likely than respondents who hunt (94%) in their knowledge about CWD in Illinois and being informed about related management practices. Most respondents did not know of the actions taken in Illinois to combat CWD , and just over half of hunters knew of the special CWD hunting season to increase recreational harvest in infected areas. Concern regarding CWD “translated into support for nearly all management options suggested, despite low levels of awareness of the disease" (Lischka et al. 2010 p230). The authors suggested that the lack of knowledge of specific management practices to control CWD was limiting the effectiveness of management and potentially "aid in the spread of the disease across the landscape" (Lischka et al. 2010 p230). They were unable to generalize the results of their data due to a low response rate within the public sample; however, the "effectiveness of disease management programs would benefit from continued efforts to learn about stakeholders affected by disease management" (Lischka et al. 2010 p232).

Vaske (2010) summarised at least 38 articles regarding human dimensions of CWD over the past seven years into seven main results and suggested future areas of human dimensions research to expand the literature on CWD. Hunters are a major stakeholder group that has been impacted by CWD; therefore a multitude of research projects have focused on hunter response, behaviour, and perceptions of the disease and related management strategies. Vaske (2010) determined, after examining the relevant literature, hunters vary in their behavioural response to CWD. While hunters are a primary stakeholder, Vaske (2010) highlighted that there are many other stakeholders who are affected by CWD. This diverse group of stakeholders potentially "have different beliefs regarding acceptable strategies for controlling wildlife disease" (Vaske 2010 p171) and more research should be done regarding the human dimensions of CWD. Not surprisingly, Vaske (2010) also found that perceived human health risks can influence behaviour. The two main predictors of human behaviour change related to CWD were “(a) high prevalence of a disease and (b) severe human consequences of a disease” (Vaske 2010 p171), where behaviour change presented to respondents is rarely based on realistic probabilities. Another main result within the literature was that perceived human health risks and agency trust influence the acceptance of management actions. Vaske (2010) found that stakeholder knowledge regarding CWD varies, not only among different groups of stakeholders but also within a group of stakeholders. Though agencies aim to inform their stakeholders, the ambiguity among various agency messages was signalling to hunters that “wildlife agencies are uncertain about CWD, which may influence trust and risk evaluations” (Vaske 2010 p174). Vaske (2010) also highlighted that there are a variety of costs associated with CWD, some of which include social, economic, and managerial. Finally, Vaske (2010) noted that not all management actions are equally accepted and or effective.

Overall, the CWD literature has largely been in agreement. Though many of the studies use the same data set, conclusions across the variety of literature were similar. Effective communication, through mediums that are well known and trustworthy, is essential to increase understanding and knowledge among hunters, government, and agencies. At current levels, or even slightly increased levels of CWD, a large portion of hunters indicated that they would not alter their hunting behaviour. Of programs that have been implemented to recruit hunters in an effort to decrease deer herd densities, monetary incentives are almost ineffective. While extra hunting tags and lengthened CWD hunting seasons are moderately more effective, these programs are not producing the desired harvest levels the programs were designed to generate.

b. <u>Economic Studies Involving CWD</u>

There have been numerous studies regarding human dimensions of CWD, but very few attempting to measure economic impacts of the disease. Bishop was the first to pioneer a study estimating economic impacts of CWD in Wisconsin for 2002, which was followed by a more rigorous study by Bishop again in 2004. Bishop's 2004 study integrated his study from 2002, and was overall more complete; therefore, his 2002 study will not be separately discussed.

Bishop (2004) examined both 2002, when CWD was first discovered in Wisconsin, and 2003. Bishop acknowledged the lack of literature in the area of economic impacts of CWD, and suggested that his article was an attempt to predict who in Wisconsin has been affected by CWD and consider potential magnitudes of hunting related impacts (Bishop 2004 p182). Just as the overall response to CWD has been driven by uncertainty, so are the economics of CWD. Bishop's analysis of the decline in Wisconsin deer hunting licences attributed approximately 10% in 2002 and 6% in 2003 directly to CWD, which was consistent with Needham et al. (2004) and Vaske et al. (2004). Bishop used a national survey of wildlife recreation activities to approximate what was being spent per year on game hunting, considered along with the decline in deer hunting he calculated a direct loss in expenditure for Wisconsin. Using this estimate, he was able to calculate the resulting loss of household income, which translated to approximately $5 million in lost in 2002 and $4 million in 2003. While no research had been conducted on the consumer surplus value of deer hunting in Wisconsin, Bishop used comparable values from other states to calculate the loss in consumer surplus. He was able to conclude that economic losses for 2002 ranged between $53 million to $79 million and in 2003 economic losses ranged between $45 million to $72 million. Bishop recognized that his analysis and estimates were made using available data and reasonable assumptions, and therefore were not overly precise, but were meant to give insights into who had been affected by CWD and by approximately how much. He also acknowledged that hunters might substitute location or activity for hunting, which would not remove revenue but simply restructure the distribution from an indirect loss and be received through alternate activities. While hunting may not have constituted a large part of the economy in Wisconsin, it could generate large regional economic imbalances. With limited potential for earning income, rural households could be severely affected regardless of the seemingly small overall impact on the Wisconsin economy.

Seidl and Koontz (2004) also recognized there was little information regarding economic impacts and potential economic impacts of CWD, noting that “the economic implications of this disease are diverse, complicated, and difficult to measure” (p241). Their region of interest was Colorado, focusing mainly upon economic implications for rural areas and government agencies.

Seidl and Koontz (2004) describe information regarding CWD similar to that presented in the previous section, and expenses related to big game hunting, wildlife viewing, the farmed cervid industry, and government agencies. They do not calculate any estimates regarding the economic impacts of CWD in Colorado, but provided insight on how CWD would affect recreation activities, government, and research. Future research, they indicated, is required to estimate impacts on Colorado's economy, and suggested evaluating site specific economic impacts.

Zimmer (2009) is the only other known study that looks into the economic effects of CWD. She determined the economic impacts of CWD for the study region along the Eastern to South-Eastern border of Alberta. Choice behaviour was modelled using logit and nested logit models using with attributes such as, CWD prevalence, culling of herds, and provision of extra tags. Stated preference and revealed preference data were collected through an internet survey of both rural and urban respondents. Zimmer found hunters were negatively affected by CWD and the culling of herds but positively affected by the provision of extra tags. The survey also presented simulations which altered disease prevalence and management programs, with this information, welfare assessments were then calculated. Zimmer determined the welfare measure for avoiding high prevalence of CWD was $9.68 per hunter per trip with differences observed in hunting trip destinations.

To the best of our knowledge, these three studies are the only ones that provide economic assessments of CWD impacts. While general values were reported in Bishop (2004) and Seidl and Koontz (2004), Zimmer (2009) calculated a regional welfare measure based on a survey designed to specifically for computing economic impacts of CWD. Overall, future research is required on the economic impacts of CWD, in particular at the regional level.

B. <u>Economic Analysis of Hunting and Recreation Demand</u>

There is a vast literature covering hunting and recreation demand. Within this diverse collection, there are a number of studies which range from valuing hunting or fishing to non-consumptive recreation activities like hiking or wildlife viewing (Zimmer 2009 p17). Within Canada, there have been a number of studies valuing big game hunting, such as Boxall (1995), Condon and Adamowicz (1995), and Sarker and Surry (1998); however, there has been little regarding valuation of deer hunting in Alberta.

While management tools to control deer populations have been studied, none have been in relation to CWD. Schwabe et. al. analyze "hunter choice over site and season selection to derive the values of changes in season length" (2001 p131) using a nested random utility model. In 1992 Creel and Loomis modeled hunting demand with and without bag limits and estimate welfare measures at current levels and following quality improvement. Alternately, Decker and Connelly (1989) examined using antlerless deer as a management tool. While these studies provided valuable insight into hunting demand and valuation, the use of multiple management programs complicates the application of these studies to determine hunter behaviour and CWD impacts in Alberta during the study period.

There have been a limited number of studies regarding wildlife disease and the relationship to hunting, focusing mainly on risk perception of potentially infected animals. It is angler response to fish consumption advisories that is most pertinent to the issue of CWD and hunter behaviour. While initial studies in angler response to fish consumption advisories found almost no behavioural changes, Diana and Bisogni (1993) and May and Burger (1996), and later studies, such as Jakus et al. (1997) identified an angler behavioural change and then calculated the resulting economic loss.

Jakus and Shaw (2003) used a behavioural model to incorporate endogenous risk perceptions about products, which used recreational fishing and defined 'keeping a fish' as an alternative for lack of a perceived hazard. Individuals make choices "based on their own personal risk assessment … [therefore] welfare estimates generated from a perceived hazard/product choice model may differ across individuals according to the perceived risks on which behavioral choices are made" (Jakus and Shaw 2003 p78). Recreational fishers are presented with a risky choice: do they fish where potentially contaminated fish live? Fish Consumption Advisories (FCAs) warn against consumption of particular fish due to toxic contamination. The model developed by Jakus and Shaw (2003) utilized the observed behaviour of whether or not an angler, at a given site, took any of their fish home; assuming the fish would be consumed if it was taken home. From there, Jakus and Shaw (2003) were able to develop a perceived hazard associated with fish caught at a particular site, “the intuition is simply that the angler who keeps a fish from a contaminated site reveals something about the perceived risks associated with doing so” (p78). They determine that the “probability of not keeping a fish can be interpreted as a survival function; this is used then as a measure of perceived hazard and incorporated as a site attribute in the site choice portion of the model” (Jakus and Shaw 2003 p78), this was a step in “linking observed behavior about taking risks to other observed behaviors, shedding light on how risk information is processed” (Jakus and Shaw 2003 p78). The survey used in this research project did not directly ask anglers about risks associated with consuming fish.

This study used two models, the first was a site choice model and the second was “a model of the decision to keep a fish at any given site” (Jakus and Shaw 2003 p82). The two models are linked in a recursive fashion because “the ‘keep fish’ portion of the model feeds into the site choice model as a predicted variable but not vice versa” (Jakus and Shaw 2003 p82). Jakus and Shaw (2003) assumed that site choice is composed of a function of site attributes, such as travel cost, average catch rate per trip, an index of reservoir ecosystem health, a measure of accessibility, and the perceived hazard measure (p84). This model allowed them to “link factors believed to influence perceived risk to product choice” (Jakus and Shaw 2003 p84) and avoided omitted variable error, an improvement over standard models. From these models, Jakus and Shaw (2003) were able to estimate welfare measures by changing the degree of perceived hazard in the perceived hazard model, calculating the new level of perceived hazard, and allow the new perceptions to influence product choice. The scenario estimated by Jakus and Shaw (2003) was PCB mitigation and removal of contaminated fish so that fish consumption advisories could be lifted. Through the hazard perception model, they found that there was a lower benefit for catch and release anglers than consumption anglers.

An important empirical finding from the perceived hazard model was increased perceived hazards associated with increased severity of the hazard warning (Jakus and Shaw 2003 p89). There was also a strong correlation between angler experience and prior risk beliefs, the empirical model showed how prior risk beliefs influenced perceived hazard and therefore site choice (Jakus and Shaw 2003 p89).

The report published by Breffle et al. (1999) estimated the compensating variation related to the elimination of Green Bay fish consumption advisories, which used observed frequency data, stated choice data, and stated frequency data. The calculation for damages, because of ploychlorinated biphenyls (PCBs) released into the water, included losses that had already occurred and losses that were projected to continue until the fish consumption advisory is lifted. PCBs accumulate through the food chain and become concentrated in fish. I In 1976 Wisconsin, followed by Michigan in 1977, issued fish consumption advisories (FCAs) in Green Bay. Breffle et al. (1999) classified losses from FCAs into four categories: reduced enjoyment from current Green Bay fishing days, losses by Green Bay anglers from fishing at substitute sites, losses by Green Bay anglers who take fewer total fishing days, and losses by other anglers and non-anglers (p1-5). This report only calculated the loss for the first two categories and not the third and fourth, therefore the losses understate the recreational fishing damages for the interim period of 1981 – 1999 and damages for future losses beginning in 2000.

While anglers had "spent over $900 million on recreational fishing" (Breffle et al. 1999 p2-21) in 1996, this did not include how anglers value their fishing experience, sites, or specific fishing days. Breffle et al. (1999 p2-22) acknowledged the lack of literature on valuation of changes in toxins and FCAs and that such a valuation varies across sites.

The data used in this report was from a sample of anglers who fished in the Wisconsin waters of Green Bay. With this sample, Breffle et al. (1999) were able to estimate "the value of service flow losses with a large sample of anglers who are specifically knowledgeable of the resources and injuries of interest, and the survey is designed so that valuation questions are relevant to respondents" (p1-7). Most anglers in this study were found to be aware of the FCAs and PCBs, and cleaning up PCBs so that FCAs could be removed was one of the most important improvements that could be made to Green Bay (Breffle et al. 1999 p4-1). A large number of anglers changed their fishing behaviour in Green Bay due to the PCB contamination and the FCAs. Breffle et al. (1999) found that respondents living within the study area were reporting FCAs more consistently with Wisconsin FCAs advisories than respondents who lived outside of the study area, such as those in Michigan. Wisconsin advisories were known to be stronger than Michigan advisories, which may have influenced some respondents.

Green Bay was noted to be a unique fishing location due to its geographic location along with a unique mix of species for recreational fishing. In addition to open water fishing, ice fishing is common on the waters of Green Bay in the winter months. The FCAs continue to vary over the years around the waters of Green Bay; however, the continuing intent of FCAs has been to alter angler behaviour through education of potential health risks. It has been these behavioural changes, ranging from “reductions in trip taking to changes in how fish are prepared and cooked” (Breffle et al. 1999 p2-18). According to Breffle et al. (1999), it is these behavioural changes that “represent recreational fishing services that have been lost (damages) to anglers” (p2-18). They found that anglers were taking fewer trips to contaminated sites, and that these trips may have been substituted with other sites. In the situation of substitution, anglers would be facing higher travel costs and inferior sites, while some anglers may not have fished at all due to FCAs (Breffle et al. 1999 p2-21).

The two types of stated choice data, also called stated preference (SP), were combined with observed angler behaviour, also called revealed preference

(RP) data, to estimate the willingness to pay (WTP) to reduce or remove Green Bay FCAs, the WTP per Green Bay fishing day, and the WTP per fishing day. SP and RP provide different information about angler preferences, so the combination of SP and RP data leads to better estimates of angler preferences (Breffle et al. 1999 p5-2). The strength of the RP data was in predicting trip taking behaviour, where as the strength of the SP data was in determining the rate at which anglers trade off site characteristics (Breffle et al. 1999 p6-1). The combined SP and RP model estimated by Breffle et al. (1999) was consistent with traditional recreation demand models. This type of estimation was useful for predicting "how changes in FCAs or other Green Bay characteristics such as catch time will affect the proportion of fishing days spent at Green Bay versus other sites ... holding total fishing days constant" (Breffle et al. 1999 p7-3).

C. <u>Summary</u>

Within the CWD social science literature the research results are essentially similar regardless of location; hunters will not change their hunting locations and behaviour unless CWD had reached widespread infection or it became a zoonotic disease transmissible to humans. While there was support for government action, it relies on stakeholder support, which was found to be influenced by clear and effective communication on CWD. Further management problems arose through perceived risks and reduced hunting more than actual risk would. In addition, reward programs for hunter increased harvest, were not particularly effective, especially monetary incentives. The limited research regarding the economic impact of CWD allows for a variety of future research. While the initial studies of economic implications of CWD used many assumptions, the previous study by Zimmer (2009) and this study attempt to gather data from hunters to increase the validity of the results assessing hunter response to CWD and the economic impacts. While these later two studies focus on a region within Alberta, the results can be extended to Alberta.

The recreation/hunting demand literature is very extensive; there has not been a great amount of research regarding disease management and its relationship to hunting demand. Studies involving angler response to fish consumption advisories closely relates to hunters and their response to CWD, both of which utilize perceived risk and/or actual risk. By extending the work done by Zimmer (2009), this follow up study attempts to increase knowledge in recreation demand literature and the CWD literature by utilizing the multi-year data to examine changing preferences/perceptions and the resulting economic impact as CWD spread and prevalence increase.

Chapter 3 – Theory and Methods

A. Introduction

The economic valuation of hunting is a complex task. While knowing relevant expenditures is important, knowledge of expenditures does not explicitly lend itself to calculating welfare changes. Recreational hunting is an activity is considered a non-market activity because recreational access and environmental services are not priced in a market; therefore, the economic value of hunting or the change in economic value associated with a quality change like the influences of CWD requires the use of non-market tools. These use information on expenditures and behaviour to evaluate consumer surplus or economic welfare associated with the non-market activity. To compute a relevant welfare impact, detailed behavioural analysis is also required to determine welfare impacts. Such behavioural analysis, in the case of hunting, would include such things as changing the wildlife management unit in which you hunt, decreased hunting enjoyment, and increased congestion within particular wildlife management units. While these behaviours are not intuitively associated with monetary value, employing economic theory and econometrics allows for translation into monetary terms. This chapter describes the economic theory and econometric methods used to derive the welfare measures associated with this study.

B. <u>Travel Cost Models</u>

Hotelling first introduced his travel cost model in 1947, in a letter to the National Park Service, further developed by Clawson in 1959. The general principle is that by accounting for the number of trips taken and the cost of each trip taken reveals a relationship between price, defined by the travel cost, and the number of trips. Travel cost, in this context, functions as the price for estimating demand for each trip site. Travel cost, therefore, represents an implicit access/entrance fee for a site; where according to demand theory, as the site fee increases for a particular site one expects that the number of visits to that site would decline. The response of an individual to various site fee changes captures their willingness to pay for access to the site. The travel cost itself is not only composed of monetary expenditures, but also the opportunity cost of an individual's labour-leisure trade off. The travel cost model, as it is known today, utilizes site characteristics and socioeconomic characteristics along with the monetary expenditure and the opportunity cost of labour-leisure to predict the number of trips taken to each site in an individual's choice set.

Early in the travel cost literature, Clawson (1959) developed the zonal approach, which groups residents living a similar difference from a recreation site; to account for population differences among zones, "visits are divided by population yielding visits per capita" (Ward and Loomis 1986 p168). This approach assumed that preferences are on average the same throughout a zone, but cannot be applied to a majority of the zonal population. The zonal approach had other problems, including the loss of information due to highly aggregated data and the “inability to separate out the influence of travel time from travel cost” (Ward and Loomis 1986 p168).

The zonal travel cost models were known to be statistically inefficient which reduced the accuracy of the estimated price. To overcome the short comings of the zonal travel cost model, an individual observation based framework was developed in the 1970s. It was first discussed by Burt and Brewer (1971) and again by Brown and Nawas (1973). They suggested gathering information, from a random sample of individuals within a study area, about the number of trips taken seasonally, related expenditures, and other relevant trip information. Then the number of trips taken could be regressed upon travel cost and other relevant variables, unique to each individual. This approach reduced multicollinearity and increased the precision of the estimators; however, Ward and Loomis (1986 p169) identified two challenges with this approach. First, if an individual only takes one trip per year (by choice or by various constraints), it becomes difficult to estimate demand and can then overstate consumer surplus, and second, the “probability of participation as a function of distance is ignored” (Ward and Loomis 1986 p169).

Further methodological refinements were made, which allowed for site substitution into travel cost models. Hanemann (1978) was the first to apply a random utility framework to travel cost models, which allows “for substitution (through allowance of multiple sites), non-consumption, and non-monetary quality attributes" (Zimmer 2009 p21). There are limitations to the random utility model (RUM) for estimating travel cost demand, notably when there exists a corner solution zero demands at some sites. Kuhn-Tucker and dual models address this problem through a "unified and utility consistent framework" (Phaneuf 1999 p86) from which corner solutions can be estimated.

C. <u>Recreation Demand Literature – Random Utility</u>

Recreation demand is defined by the demand for a certain recreation site with a given price (or the travel cost) and its associated attributes along with substitute recreation sites each with its own price and related attributes. The objective is to maximize an individual's utility given a series of constraints, such as time and income. There is extensive literature on the topic of recreation demand, ranging from papers to textbooks, which strives to explain how individuals make rational decisions for a particular alternative given the available information.

a. <u>Demand for Attributes</u>

In the random utility case, following the discussion from Ben-Akiva and Lerman (1985), an individual chooses an alternative (e.g. a hunting site), q, given the set of attributes, a_1 through a_L, which comprise each of the alternatives.

$$q = (a_1, a_2, ..., a_L) \tag{3.1}$$

The alternative that was chosen is assumed to make the individual as happy as possible, in other words, it is utility-maximizing, subject to the given constraints. Utility (U) is an ordinal function, in the case of recreation demand it is based on all available alternatives (*q*) and all prices, which are represented by the associated travel cost (Zimmer p22).

$$U = U\ (q_1, q_2, \ldots, q_L, TC_1, TC_2, \ldots, TC_L) \tag{3.2}$$

Unlike neoclassical consumer theory, "where the feasible choices are continuous variables" (Ben-Akiva and Lerman 1985 p58) the alternatives in the random utility approach represent discrete choices. When there is a continuous choice set, calculus can be used to derive the demand functions; however, when there is zero consumption of one or more of the alternatives, utility functions are used instead of deriving demand functions because there may be corner solutions and usual first-order conditions may not hold.

From the universal set of alternatives (*C*) an individual faces various constraints that determine a sub-set of the original alternatives (C_n) which are available to the individual.

$$C_n \subseteq C \tag{3.3}$$

An individual's utility function (U) is dependent on his or her own unique sub-set of alternatives (*n*). Consistent with consumer theory, "the individual is assumed to have consistent and transitive preferences over the alternatives that determine a unique preference ranking" (Ben-Akiva and Lerman 1985 p47). The utility for each alternative is

$$U_{in}, i \in C_n \tag{3.4}$$

where the alternative is indexed by *i* for person *n*. Alternative *i* will only be chosen, if and only if, its utility is greater than the utility of the other alternatives within the same sub-set

$$U_{in} > U_{jn}\ , \ \forall j \neq i, \ j \in C_n \tag{3.5}$$

where *j* is another alternative within the same choice sub-set.

Attributes and prices of various sites comprise the site choice decision within recreation demand. The utility of a site can be defined by

$$U_{in} = U\ (Q_{in}, Z_n, TC_{in}) \tag{3.6}$$

where the utility (U) is composed of a vector of attributes (*Q*) for alternative *i*, a vector of characteristics (*Z*) for person *n*, and the travel cost (*TC*) for person *n* and the alternative *i*.

For this study, and Zimmer (2009), travel cost is used as a proxy for price since the basic costs of hunting, such as licensing costs, do not represent total expenditure of a hunting trip nor does it account for the number of hunting trips taken. When calculating the final travel cost used in model estimation, real wage, opportunity cost of time, and distance are taken into account. In the utility function, travel cost is included as a variable, and applying this method over all the sites and all the respondents demand equations can be created (Zimmer 2009 p24). This multiple site model has been used in a variety of hunting studies.

Thus far, attributes were assumed complete and known with certainty to the individual and the researcher. That assumption can be relaxed when considering the random utility models presented below.

i. Random Utility Models (RUM)

Under the assumption that individuals choose the alternative that gives them the highest utility, the random utility approach is generally consistent with consumer theory. Observational deficiencies, on the part of the researcher, can produce inconsistent results. To correct for such inconsistencies, the analyst treats the utilities as random variables because they are not known with absolute certainty. While the indirect utility function is represented by *V*, and is deterministic, or non-random, including a term to account for random error, ε, allows uncertainty to be included in the model.

$$U_{in} = V_{in} + \varepsilon_{in} \tag{3.7}$$

Assuming that there are no ties and a joint probability distribution for the set of random utilities, the "probability of alternative *i* is equal to the probability that the utility of alternative *i*, U_{in}, is greater than or equal to the utilities of all other alternatives in the choice set" (Ben-Akiva and Lerman 1985 p55).

$$P(i \mid C_n) = \Pr[U_{in} \geq U_{jn}, \forall j \in C_n] \tag{3.8}$$

Equation 3.7 combined with equation 3.8 results in

$$P(i \mid C_n) = \Pr[V_{in} + \varepsilon_{in} \geq V_{jn} + \varepsilon_{jn}, \forall j \in C_n] \tag{3.9}$$

Equation 3.9 is divided into its deterministic and random components, and then rearranged to form

$$P(i \mid C_n) = \Pr[\varepsilon_{jn} - \varepsilon_{in} \le V_{in} - V_{jn}, \forall j \in C_n, j \ne i] \tag{3.10}$$

Equation 3.10 shows that overall utility values are not important, it is the difference between them that creates the probability for a site choice while retaining their ordinal properties. Given this framework, a research specific RUM can be created with respect to the probability distribution of the error terms and the number of alternatives within the given choice set C_n. For this study there were more than two sites, or alternatives, for hunters to choose from; therefore, a multinomial choice model will be developed.

Assuming a type I extreme value, or Gumbel, distribution it is assumed that the error differences have a logistic distribution; therefore generating a multinomial logit (MNL) model

$$P_n(i) = \frac{e^{\mu V_{in}}}{\sum_{j \in C_n} e^{\mu V_{jn}}} \tag{3.11}$$

where μ is the scale parameter, which is inversely related to the variance of the error distribution. The Gumbel distribution can be considered as an approximation to a normal density, which is convenient for analysis; however, it is the independent and identically distributed (IID) property which is the more important restriction. Assuming the error terms are IID implies that all the random terms have the same variances and are independent of each other. Another important assumption is independence from irrelevant alternatives

(IIA), which means that for a given individual the ratio of the "probabilities of any two alternatives is entirely unaffected by the systematic utilities of any other alternatives" (Ben-Akiva and Lerman 1985 p108). While IIA applies to each homogeneous group, "it does not apply to the population as a whole" (Ben-Akiva and Lerman 1985 p110), and may have to be relaxed in some cases.

While there are different ways to relax the IIA assumption; however, for this study a nested logit (NL) model will be used to account for the substitution among recreational sites. The nested logit and welfare measures discussions are largely based on Bockstael and McConnell (2007). The elements of C_n share both observed and unobserved attributes; therefore, the utilities of various alternatives cannot be considered independent. This requires the relaxation of the IIA property within the MNL model. A nested logit structure increases flexibility, reduces the limitations of the IIA property, and can be used to test if IIA holds.

The nested structure allows choices to be broken down into stages, given the nature of this study a two level nested model will be discussed. When an individual makes a decision, they will choose an alternative (or branch) that is located within a specific group (or limb), forming the decision. To form the decision structure, the choice set is first subdivided into different limbs, grouping the alternatives into branches within the limbs. Alternatives within a given limb share some commonality that is not found within the other limbs. Now, the IIA property holds within a nest (i.e. alternatives κ, τ, and φ), but not across nests (i.e. alternatives κ, τ, φ, χ, ψ, and ω all together do not hold the IIA property).

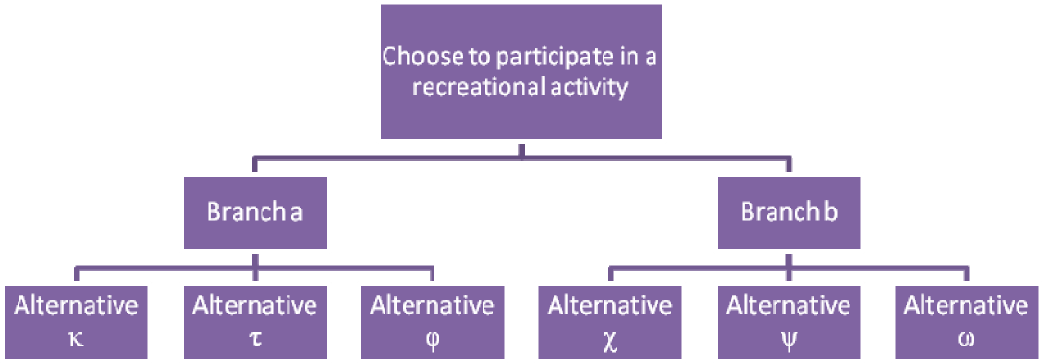

Figure 3 – 1. Example of decision for a nested logit model.

This assumption requires that a more general distribution, the generalized extreme value distribution (GEV), assumed for the estimation. The GEV is consistent with jointly distributed errors which allows for "different patterns of correlation across alternatives" (Bockstael and McConnell 2007 p120), which is an important part of decision making which researchers cannot observe.

The nested structure can complicate the prediction of site choice, relative to a MNL. The probability of an individual choosing an alternative is the probability of choosing branch *a* multiplied by the probability of choosing alternative *i* from within branch *a* (Zimmer 2009 p27).

$$\Pr(ai) = \Pr(i|a)\Pr(a) \tag{3.12}$$

Specifically, the probabilities multiplied in equation 3.12 are those which represent the lower choice level, equation 3.13, and those which represent the upper choice level, equation 3.14.

$$\Pr(i \mid a) = \frac{\exp(\alpha q_{ai_a} + \beta(y - p_{ai_a}) / \theta_a)}{\sum_{j_a=1}^{J_a} \exp(\alpha q_{aj_a} + \beta(y - p_{aj_a}) / \theta_a)} \tag{3.13}$$

$$\Pr(a) = \frac{\exp(\gamma b_a + \theta_a I_a)}{\sum_{g=1}^{A} \exp(\gamma b_g + \theta_g I_g)} \tag{3.14}$$

Assume that *q* and *p* are vectors of site quality and attributes which vary over all alternatives, while α and β are the coefficients, respectively. The vector of variables that vary between nests, not within them, is represented by *b* and γ is the vector of coefficients for the variables *b*. θ is a measure of the degree of independence between alternatives within a nest and *I* is the inclusive value for a given nest; it is the inclusive value that links the two formulas. The inclusive value uses a log sum calculated from equations 3.13 (the lower choice level) and 3.14 (the upper choice level). It is the results of the lower choice level estimation used within the upper choice level which takes the form of the log sum.

$$I_a = \ln \sum_{j_a=1}^{J_a} \exp(\alpha q_{aj_a} + \beta(y - p_{aj_a}) / \theta_a) \tag{3.15}$$

A log likelihood (LL) function is used to determine the parameters for equation 3.15. It is the LL function which “represents the probability of observing the choices in the sample as a function of the probability of an individual (*n*) choosing a certain alternative (*i*) from branch (*a*)” (Zimmer 2009 p28).

$$L = \sum_{n=1}^{N} \sum_{a=1}^{A} \sum_{i=1}^{J_n} y_{nai} \ln[\Pr(nai)] \tag{3.16}$$

As in Zimmer's (2009) study, a full information maximum likelihood (FIML) approach is taken, using the econometrics program NLOGIT 4.0 that can automatically calculate the NL model from this approach, and the FIML is both consistent and asymptotically efficient.

ii. Heterogeneity

While MNL and NL models are fairly common within this genre of literature, there are some disadvantages when attempting to reproduce real choice behaviour. Both MNL and NL models assume that preferences of all individuals within the sample are identical. However, this assumption is not entirely realistic when individuals make their decisions based on individual traits and past experiences. A simple way to account for the lack of homogeneity within the sample is to utilize interaction variables. This allows for relationships between variables, for whatever reason, to be taken into account within the estimation. Following Zimmer (2009), this study will also incorporate interaction variables to better "represent heterogeneity among hunters" (p29).

Swait (2007) indicates that "the assumption that tastes vary at the individual level may be overly detailed and the operationalization of such meticulous modeling insights [are] impracticable" (p251). From marketing theory, the latent class model (LCM) utilizes the notion of grouping the respondents, unlike a NL which groups choices. Within the LCM there are a finite number of segments which "have within-segment homogeneity of tastes" (Swait 2007 p251). The LCM approach groups individuals according to similar tastes which cannot be observed by the researcher. Similar to the NL model, the LCM is a two-stage model which includes a choice model conditional on group membership and a group membership model (Swait 2007 p252).

McFadden and Train's (2000) mixed MNL model, or random parameter logit (RPL) model, also addresses issues regarding heterogeneity in choices. While the LCM groups respondents with similar tastes, the mixed MNL assumes that individual tastes are "assumed to be multivariate normally (MVN) distributed in the population" (Swait 2007 p255). This gives each individual two random components in their utility function, and this allows for different taste preferences, which prevents the IIA assumption from heavily influencing a respondent's preference structure (Zimmer 2009 p30). The way in which the mixed MNL model can relax the homogeneity assumption makes this one of the preferred method for modelling real choice behaviour.

iii. Welfare Measures

Following Zimmer's (2009) approach, welfare measures will be developed to monetarily quantify the impact of CWD on hunters. This study, will utilize compensating variation (CV) and is commonly found within recreation demand literature and other studies using NL estimations. CV evaluates the "difference between the expected values of utility before and after a change" (Zimmer 2009 p30). More generally, according to Bockstael and McConnell (2007 p18) CV is the payment necessary, whether positive or negative, to make an individual indifferent between the original situation and after a change.

In its simplest form, when there is no random component within the utility function, CV is defined as

$$V^0(P,Q^0, M) = V^1(P, Q^1, M + CV) \tag{3.17}$$

where P is price, Q is the environmental quality or attributes, and M is income. The addition of the random component increases the complexity of the calculation of CV when using a NL framework. Rearranging the probabilities from equations 3.13 and 3.14 creates an expression for the expected value of the maximum utility

$$\tilde{V} = \ln\left(\sum_{a=1}^{A}\exp(\gamma b_a)\left[\sum_{j_a=1}^{J_a}\exp\left(\frac{\alpha q_{aj_a} + \beta(y - p_{aj_a})}{\theta_a}\right)\right]^{\theta_a}\right) + \overline{C} \tag{3.18}$$

$\overline{C}$ is an unrecoverable constant, and, the marginal utility of income, β, is treated as a constant. These constants simplify a rather daunting looking equation because they cancel out in the difference expression. Using equation 3.18 to calculate the expected value of the maximum of the utilities for before and after a change as in equation 3.17, the resulting welfare calculation becomes

$$E(CV) = \frac{\left[\ln\left(\sum_{a=1}^{A}\left[\sum_{j_a=1}^{J_a}\exp\left(\frac{\alpha q^1_{aj_a} - \beta p_{aj_a} + \gamma b_n}{\theta_a}\right)\right]^{\theta_a}\right) - \ln\left(\sum_{a=1}^{A}\left[\sum_{j_a=1}^{J_a}\exp\left(\frac{\alpha q^0_{aj_a} - \beta p_{aj_a} + \gamma b_n}{\theta_a}\right)\right]^{\theta_a}\right)\right]}{\beta}$$

(3.19)

where q^0 is the initial level of the attribute and q^1 is the subsequent level after a change has been implemented. This represents the amount of money an individual requires to bring them back to their initial utility after a change. For this study, welfare measures will represent both the average rural and urban hunter from each study period, and how much they would be willing to pay per trip to not have CWD change, everything else held constant.

b. ***Discrete Choice Data***

When an individual is faced with a choice, they consider the set alternatives and make a decision. These choices form discrete choice data; however, the situations surrounding an individual at the time they make their decisions produces different data all with varying qualities which makes analysis for researchers challenging.

i. Revealed Preference Data

Revealed preference (RP) data comes from recording decisions made by individuals when faced with a real choice and it describes “only those alternatives that exist” (Louviere et al. 2000 p228). Largely, RP data is acquired through surveys where respondents are asked about previous decisions or through researches directly observing actual decisions. From RP data researchers are able to infer information about respondent’s preferences for attributes or qualities, current equilibriums, and are particularly good for short-term forecasting. While RP data appeared first in the consumer demand literature, it has been utilized in a variety of other areas, from psychology to recreation demand (Zimmer 2009 p32).

ii. Stated Preference Data

Stated preference (SP) data is formed through responses to questions regarding hypothetical situations, while maintaining the assumption that these responses would be analogous to those within real market conditions. While RP data can be restrictive to researchers, SP data has the ability to increase flexibility through the use of hypothetical markets. These hypothetical markets can alleviate some of the collinearity found between explanatory variables, and for the scope of this study, SP data are useful when the product is not traded within a real market. Louviere et al. (2000) note that in some cases "consumers expend such resources as time or travel effort to consume these types of goods" (p22) and while RP data can be used as a proxy, in many cases such as "the existence value of a wild caribou herd in a remote forest, no RP data exist to model the behaviour of interest" (p23). In this study, where quality or policy changes are being evaluated and it is not realistic to implement these changes and there does not exist behavioural data, or there is insufficient variation within any existing data, SP data becomes extremely useful.

While there have been criticisms regarding the accuracy of the responses produced by hypothetical situations and the validity of their results to value certain resources or attributes, according to Louviere et al. (2000) "SP surveys can produce data consistent with economic theory, from which econometric models can be estimated which are indistinguishable from their RP counterparts . . . [and] models estimated from SP data yield valid and reliable inferences about and predictions of real market behaviour" (p21).

iii. Fusion of Data

RP and SP data each have their own limitations. Through pooling the two sources of data, however, strengths of both are exploited while weaknesses are ameliorated (Louviere et al. 2000 p231). According to Louviere et al. (2000) this pooling of RP and SP data was first introduced by Morikawa (1989) when he wanted to improve the efficiency of his model parameters (Louviere et al. 2000 p231). This method of data enrichment can be especially helpful in the context of recreation demand where many scenarios cannot be realistically implemented for the purpose of evaluating welfare results. Haener et al. (2001) found that a joint model which included both RP and SP data generated results "with the most reliable predictive ability" (p640). Eom and Larson (2006) also combined RP and SP data and found that their valuation estimates improved, through exploiting statistical advantages from having more information relative to individual estimates. In addition to these examples, this approach has been applied to a variety of hunting and fishing research and literature

c. <u>Incorporation of Human Health Risk into Recreation Demand</u>

A variety of studies that evaluate the demand for hunting and angling through a number of important attributes, such as the desired game, ease of access to sites, congestion, number of animals harvested, and of course, cost (or a reasonable proxy). Health risks associated with meat consumption are included in consumer demand literature; however, human health risk as a variable that has not been extensively considered in the context of the recreation demand literature especially where animal disease is of concern.

Jakus et al. (1998) and Jakus and Shaw (2003) lead the literature which used fish consumption advisories (FCA) and incorporated the associated risk into recreation demand. While pollutants accumulate in fish and can reach levels that are dangerous for human consumption, not all fishermen may be aware of or even perceive the danger to be risky. In their 1998 article, Jakus et al. incorporated angler characteristics and used dummy variable interactions to introduce risk into decision making while taking into account the fact that not all anglers would be aware of FCAs. Through this they were able to determine a difference in site selection for those without FCAs relative to those with FCAs. Later in 2003, Jakus and Shaw developed a perceived hazard model to determine the probability of an angler keeping their catch. The intuition behind perceived hazard is that an angler who keeps a fish at a contaminated site "reveals something about the perceived risk associated with doing so" (Jakus and Shaw 2003 p78). Their empirical model used two parts, a site choice model that was linked in a recursive fashion to a model of the decision to keep a fish at any given site. This study found that previous beliefs about risk greatly influenced site choice and perceived hazards. The resulting welfare measures of anglers with different risk perceptions differed from welfare estimates for policies aimed at reclaiming fishing sites. These studies of perceived health risk and angler behaviour help guide the incorporation of human health risk into this study.

D. Variables Considered in this Study

This study, and Zimmer(2009), is concerned with examining CWD impacts on hunting behaviour and utilizes some variables that are not typically found within the current hunting literature. As a proxy for price, travel cost is an important variable in the estimation. Other variables utilized in this study are fairly new to estimating recreation demand.

a. Travel Cost

The calculation of the travel cost variable for this study, and Zimmer (2009), is based on Haener et al. (2001) and Rausch (2006). Following Zimmer (2009), taking the round trip travel distance to each hunting site (or the middle of the WMU if there were no trips made in that WMU) and multiplying by $0.30 per kilometer, which "represents the out of pocket expense for driving including such things as operating costs and ownership costs" (Zimmer 2009 p36), evaluates the driving expense. Next twenty-five percent of an individual's income, represented by *tinc*, is divided by the average number of hours worked in a year, which is assumed to be 2080 (Zimmer 2009 p36). According to Cesario (1976), "the value of time with respect to nonwork travel is between one-fourth and one-half the wage rate" (p37), in this study and Zimmer (2009), 25% of the wage rate is used to calculate the opportunity cost of time. Cesario (1976) was also able to conclude that "the marginal wage rate for the value of time-travel values in recreation benefit estimation is inappropriate, both from the theoretical and practical points of view" (p37). Multiplying the opportunity cost of time by the round trip distance and divided by an average speed of 95 km/h determines the total opportunity cost of time for a given trip. Adding the total opportunity cost of time to the total driving expense for a round trip gives the final travel cost (TC).

$$TC_i = (distance \times 2 \times \$0.30) + \left(\left[\frac{0.25 \times tinc}{2080} \right] \times \left[\frac{distance \times 2}{95 \text{ km/h}} \right] \right) \quad (3.20)$$

Through this equation both monetary and non-monetary expenses are accounted for. This includes variable costs that change as the costs of driving change, such as: insurance, vehicle maintenance, fuel, and “other necessities in travelling by automobile” (Zimmer 2009 p36). Further discussion regarding the formulation of the TC parameter used in this study, see Zimmer (2009).

b. <u>Attributes</u>

The attributes used in this study were first implemented in Zimmer (2009) and had not been previously utilized in any known CWd studies. The following description of the variables considered follows from Zimmer (2009 p35).

The variable *CWD* measures the infection rate in deer in terms of percentage of the population. The study terms, none, low, medium, and high were used to describe infection rates of 0%, 1 -5%, 6 -10%, and greater than 10%, respectively.

The dummy variable *TAGS* is used to represent whether or not extra tags were present in a given WMU for the study area. The submission of a deer head for CWD testing from a previously obtained licence would earn a hunter extra tags provided by the Alberta Government.

The dummy variable *CULL* is used to represent whether or not the Alberta Government was undertaking large scale deer population reduction within the given WMUs. This was a controversial management tool and a major undertaking by the Alberta Government to try and control the spread of CWD.

The alternative specific constants (ASCs) for each of the WMUs within the study comprised the remaining attributes. These ASCs help account for attributes not explicitly recorded within the study. While such omitted attributes may not be explicitly stated within the model, the ASCs help to mitigate any omitted variable bias that may be affecting hunter site choice. It is the ASCs that will capture other, perhaps more familiar variables, such as, site access, congestion, and type of game species.

E. <u>Summary</u>

There is a vast array of methods in the field of recreation demand to determine behaviours, costs, and welfare evaluations. This chapter seeks to provide a foundation of understanding for the models and methods used for analysis within this study. This chapter has provided summaries of the travel cost model, basic random utility models, multinomial logit models, then more specifically nested logit models, and finally the methods used to estimate CV. An introduction to the benefits and limitations of RP and SP data, as well as the enriched data set combining RP and SP data has been provided. The perceived hazard risk, from angling literature, was discussed as was its application to this study. This chapter captures the theory which forms the basis for this study.

Chapter 4 – Data

The two years of data gathered for this study came from a survey which was developed specifically for research questions posed in this study and the preceding year's study. These research questions included: will hunters change where they typically hunt due to CWD, how do hunters react to management practices and the prevalence of CWD, and what is the overall effect of CWD on hunting in Alberta? In addition, this study seeks to examine if hunters appear to be changing their preferences or if their choices are becoming more or less systematic over time. To gain insight into these research questions, revealed preference (RP) data were collected, in conjunction with contingent behaviour questions to elicit stated preference (SP) data.

The contingent behaviour questions were best suited to an internet survey, which was created by individuals in the Department of Rural Economy at the University of Alberta (Zimmer 2009). The survey was honed through focus groups with people involved in wildlife management from the Government of Alberta and Edmonton hunters. The first year of data, based on the 2007 hunting season, was gathered through the survey implemented in spring 2008. The second year of data, based on the 2008 hunting season, was gathered through implementing the survey again in 2009. A summary of survey composition, design, and data collection will be presented along with descriptive statistics for both years. Detailed information about the survey development, design, and data collection can be found in Chapter 4 of the Zimmer's (2009) thesis, *The Economic Impacts of Chronic Wasting Disease on Hunting in Alberta*.

A. <u>Survey Composition & Experimental Design</u>

In the first section of the survey, hunters were asked questions that related to hunting practices, hunting experience, and hunting attributes. The respondents also provided an estimate of their hunting expenditures and an estimate of money that was spent within the hunting area itself. This was followed by RP data collection by asking respondents to recall how many hunting trips were taken, the number of nights stayed, how many years they had previously hunted at that site, and the number of days spent at that hunting site. The respondents were provided with a map of the Wildlife Management Units (WMUs) within the study area (and the hunters are probably very familiar with the WMU locations), while space was provided for trips outside of the study area.

The next section of the survey presented information on CWD and questions that pertained to the respondent's knowledge of CWD, preferences towards management programs, infection rates, and behaviour in the presence of CWD. The contingent behaviour question was part of the CWD section and designed to elicit SP data to supplement the RP data gathered from the previous section. In the contingent behaviour question, respondents were presented with three scenarios with altered levels of CWD (none, low, medium, and high), along with the presence or absence of two management practices: culling and extra tags. The RP data gathered in the previous section were placed alongside these scenarios so that the hunters could easily reference their prior responses. Hunters then recorded how many trips and to what locations they would travel in each given scenario. The attributes in the SP questions were strictly CWD related, such as prevalence of CWD, spread of CWD, culling, and the provision of tags; therefore, the alternative specific constants (ASCs) in the econometric model, are expected to capture site attributes, observed and unobserved, that were unrelated to CWD. Of the three scenarios presented to the respondents, the first scenario was the same for each hunter: the current situation with CWD increased to medium prevalence, 5% – 10%. The two scenarios that followed were randomly selected by the computer from five planned scenarios. These five scenarios were designed by the researchers to elicit hunter response to the varying programs in each WMU, specifically to reduce collinearity between CWD prevalence and management programs. Although efforts were made to reduce collinearity, it could not be eliminated. Collinearity arose among CWD prevalence and management programs because management programs would only be initiated in WMUs where CWD was present. Though not perfect, this approach was the most realistic. The survey finished by asking respondents a few demographic questions, and, whether they were interested in participating in a future survey.

B. Data Collection

Data collection required, that during the first year the survey was implemented hunters had hunted in the study area during the 2007 hunting season, and similarly, respondents for the second year of data collection were required to have hunted in the study area during the 2008 hunting season. To obtain a sufficient sample of rural respondents for the survey, general whitetail deer licence holders were chosen as the sample base. These licence holders are permitted to hunt whitetail deer anywhere in the province, given that they have landowner permission. The small study area implied a general random sample of licence holders would be unproductive; therefore, a sample based on partial postal codes was obtained through submitting the first 3 digits of postal codes to Fish and Wildlife to search the general licence database. This provided three-hundred and fifty (350) names and telephone numbers of individuals who would comprise the rural sample. Urban hunters were represented by obtaining 350 individuals from Edmonton and Calgary who were drawn from lottery-rationed mule deer licences (or draw licences). Mule deer draw licence holders were preferred to general whitetail deer licence holders for the urban sample because of the distance to the study area from the urban centre, large population, and because these hunters had applied for, and won the draw, they would be quite likely to have made at least one hunting trip to the study area. The pool of potential respondents was contacted by telephone and asked two screening questions before being formally invited to participate in the survey (Zimmer 2009).

From the pool of potential respondents each year, the final number of respondents in the first year was 90, with 24 rural participants and 66 urban participants. The final number of respondents in the second year was 40, with 3 rural participants and 37 urban participants. Of the respondents from 2007, 40 respondents participated again in the survey in 2008. There is the potential for over-representation of individuals who were concerned with the management of deer populations; therefore, there is the potential for selection bias that will affect the results.

C. <u>Descriptive Statistics</u>

On average, most of the respondents from the first year of data collection were males over 40 years of age with some level of secondary education with household incomes over $60,000. A majority of respondents had been hunting since childhood, completed a hunting training course when they were in their youth, and have hunted in excess of 20 years. 74% of respondents lived in an urban area; also, 74% of respondents had no children in their household. The respondent's weapon of choice was the rifle, followed by bow and arrow. Hunting activity was most common on both crown and private land, and most respondents did not leave Alberta or Canada to hunt in 2007.

Comparatively, the respondents from the second year of data collection were, on average: male, over 45 years of age with some post-secondary education, and household income greater than $60,000. Again, a majority of respondents had been hunting since their childhood, completed a hunting training course while they were in their youth, and have hunted for over 20 years. 93% of respondents lived in an urban area; also, 75% of respondents had no children in their household. Similar to the respondents in 2007, the respondents from 2008 also preferred the rifle followed by the bow and arrow, and hunting activity was most common on both crown and private land with most respondents not leaving Alberta or Canada to hunt.

Hunters in both 2007 and 2008 were asked to indicate their favourite wildlife management unit (WMU) from the study area. The option of "Other" was most frequently chosen in the 2008 study period; however, from within the study area WMU 151 was the favourite in both years, and closely followed by WMU 200 in the 2008 study period. Hunters in the second year were moving outside of the study region to a great extent, relative to the first year of the study. WMU 151 has had multiple confirmed cases of CWD, while during the study period there were no cases of CWD in WMU 200. The first confirmed case of CWD in WMU 200 was in November of 2009.

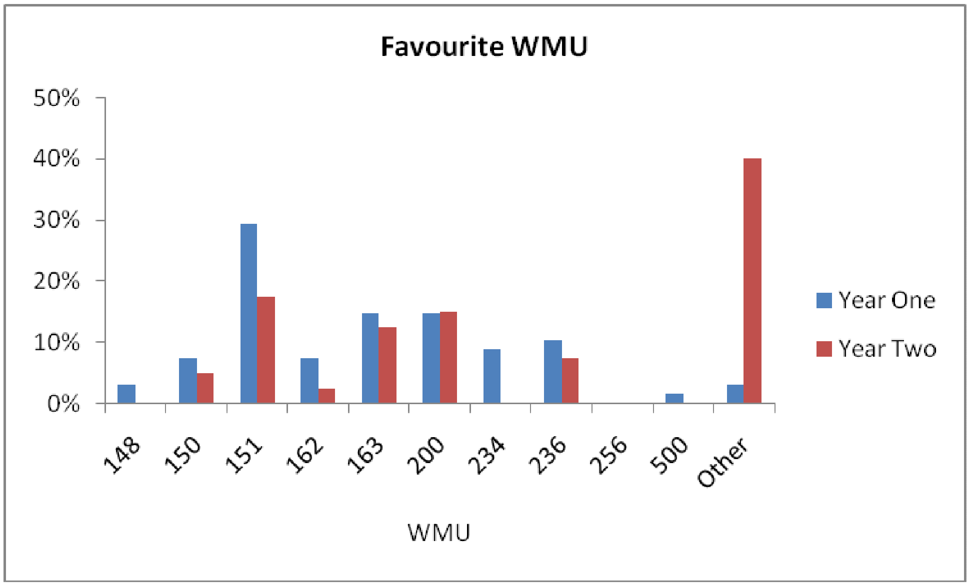

Figure 4-1. Number of hunters that chose each Wildlife Management Unit (WMU) as their favourite.

In both years, hunters were asked to estimate their expenditures. Gas was the highest expenditure, followed closely by both food & beverage, and equipment in both 2007 and 2008. In 2008, the expenditure on gas was substantially higher for rural than for urban respondents.

Table 4-1. Average estimated hunting expenditures spent in rural Alberta during the 2007 & 2008 hunting season by hunters themselves.

	2007	2008		
Expenditures	*Average Expenditure (N=90)*	*Average Expenditure (N=40)*	*Average Urban Respondent Expenditure(N=37)*	*Average Rural Respondent Expenditure(N=3)*
Gas	$468.65	$452.38	$430.89	$850.00
SE	$47.73	$70.59	$68.26	$650.00
Accommodations	$106.84	$168.59	$177.70	$0.00
SE	$18.42	$37.88	$39.39	$0.00
Guiding Fees	$4.04	$5.13	$5.41	$0.00
SE	$3.69	$4.02	$4.24	$0.00
Food & Beverage	$224.37	$238.13	$244.24	$125.00
SE	$22.32	$40.82	$42.72	$75.00
Equipment	$472.76	$369.59	$376.05	$250.00
SE	$92.28	$80.93	$85.21	$50.00
Butchering	$128.12	$136.38	$135.65	$150.00
SE	$23.25	$32.82	$34.12	$150.00
Licencing	$89.44	$81.23	$80.49	$95.00
SE	$5.60	$5.80	$6.02	$25.00
Total Expenditures	$1494.22	$1451.44	$1450.43	$1470.00

*Using a simple t-test, it was determined that the total average expenditure for 2007 and 2008 were statistically no different.

In both 2007 and oddly 2008, only one respondent had not heard of CWD prior to the survey. In 2007, approximately half of the respondents thought that CWD was a threat for wildlife while 12% thought it was a threat to humans. Then in 2008, slightly over half of the respondents thought that CWD was a threat for wildlife, whereas, 18% thought it was a threat to humans. When respondents were asked what CWD would do to hunting, in 2007, 41% thought that hunting would decrease, which increased to 53% in 2008, while 26% in 2007 and 28% in 2008, thought hunting would remain unchanged.

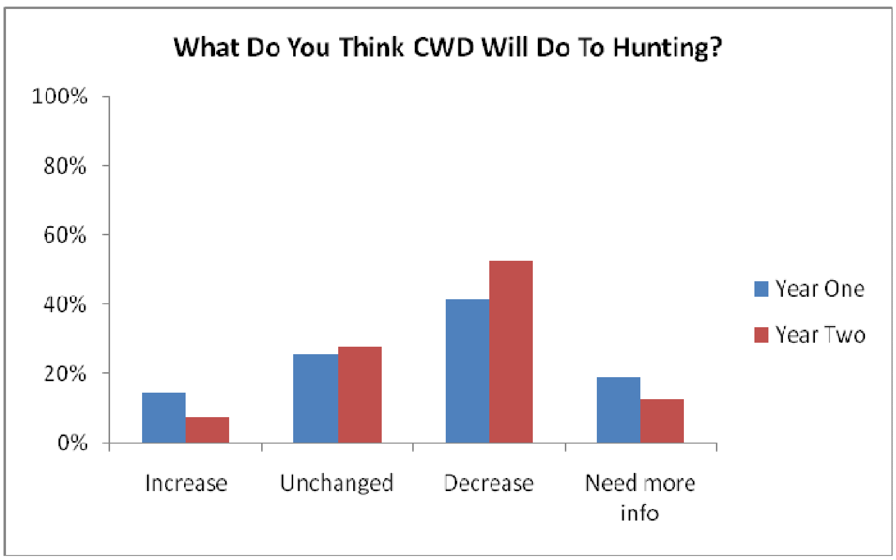

Figure 4-2. Responses for the 2007 & 2008 hunting seasons.

Other opinions about hunting activity were elicited by asking respondents, from both study years, to what degree they agreed that CWD had no affect on their hunting activities and wheather they had changed the species they normally hunt due to CWD. The graphs below show a shift in hunter activity between the two study years, where respondents from the 2008 study season are more adversely affected by CWD.

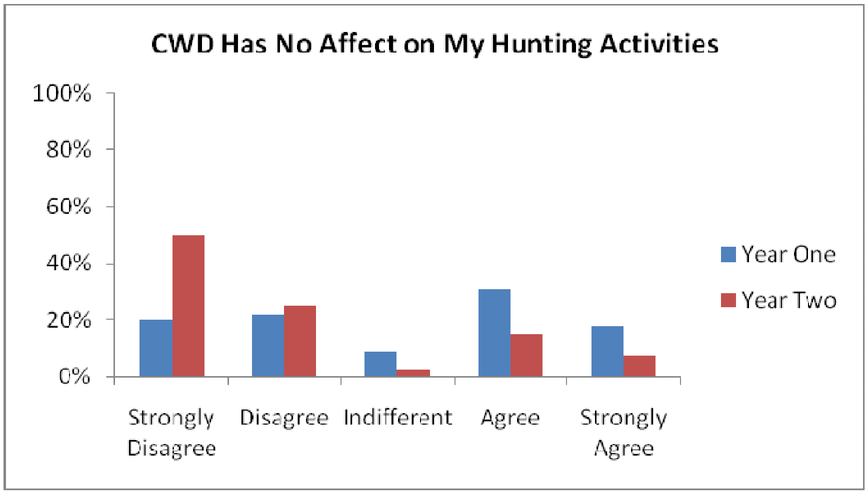

Figure 4-3. Responses for the 2007 & 2008 hunting seasons.

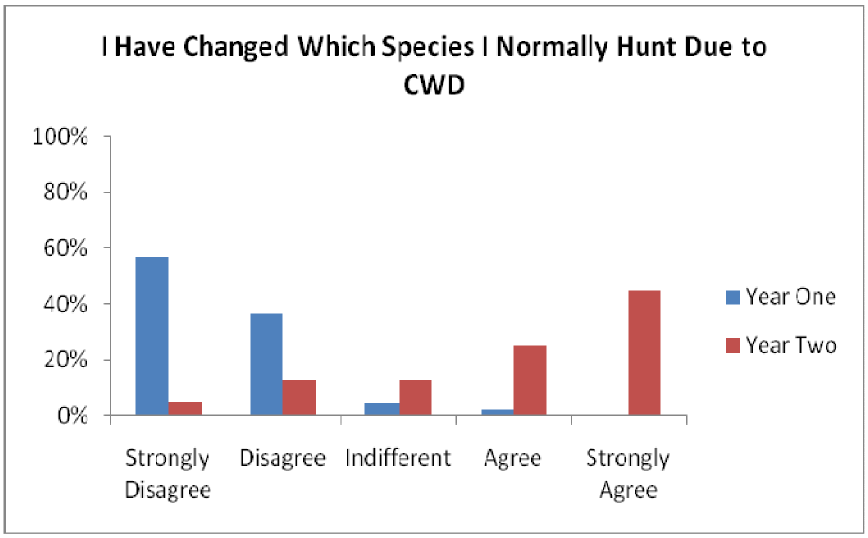

Figure 4-4. Responses for the 2007 & 2008 hunting seasons.

The response to an extended hunting season was notably different between the two years of data, 84% said they would participate in 2007, while only 60% said they would participate in 2008. Respondents who were satisfied or very satisfied with research of the CWD prion, properties, and the disease itself decreased from 68% in 2007 to 45% in 2008. When asked if they had changed the species they normally hunt due to CWD in 2007 only 2% of respondents agreed, while in 2008 70% of respondents agreed or strongly agreed. Of the respondents from 2007, 37% said that they ate or gave away deer meat before getting CWD results back from Fish & Wildlife, whereas in 2008 none of the respondents did. These responses may reflect a shift in hunter attitudes towards CWD, or, it may be that respondents from the 2007 survey who were more concerned about CWD agreed to participate again the following year in the 2008 survey which could lead to selection bias.

D. Summary

The survey implemented in 2007 and 2008 were designed to answer specific research questions regarding CWD and hunting behaviour. The disease is relatively new to Alberta and its effect on hunters not well understood. Questions to elicit RP and SP data were asked. The first part asked general qualitative and quantitative questions about hunting and then became more specific as to the respondents reaction and ideas regarding CWD. The SP data were obtained through three contingent behaviour questions where different CWD scenarios were presented. The study area was along the Eastern to South-Eastern border of the province with 10 wildlife management units (WMU), some of which contained CWD and others which posed the potential areas for CWD to spread. Hunter contact information was supplied by the hunting licence database of general whitetail deer for the rural population and draw mule deer for the urban population; hunters were then randomly selected for participation. Respondents were initially contacted by telephone and were asked two screener questions before formally being asked to participate in the survey. The survey was completed online while the results were recorded in an online database. The next chapter will discuss the results of the 2008 estimations and the multi-year estimations.

Chapter 5 – Results

The results from the analysis of the survey data are presented in this chapter. Individual Revealed Preference (RP) and Stated Preference (SP) models of the second year of survey data are discussed. The survey design allows for combination of the RP and SP data, so, the chapter discusses joint RP and SP models, utilizing only the second year of survey data. Finally, joint RP and SP models, which include both years of data, are discussed. In addition, welfare calculations, evaluating the economic benefits of CWD management programs, will be presented.

A. <u>Revealed Preference Models for the 2008 Hunting Season</u>

The RP data obtained through the second year's survey included actual trips to Wildlife Management Units (WMUs) in the study region. However, as in the data from the first year of data collection, these data lacked variation in certain variables, and no trips were taken to certain WMUs. Lack of variation in independent variables is common in this type of RP data. In this case there was high collinearity between management programs and CWD. To acquire working RP models for the second year's data set, some modifications were needed. The choice set was reduced from 11 WMUs to 8 WMUs. WMU 500 was removed because no trips were taken to that alternative in the second year responses. The two trips to WMU 148 were combined with WMU 150 and the four trips to WMU 162 were combined with WMU 163, because less than one percent of total trips taken and approximately one percent of total trips were taken to these WMUs, respectively. WMU 148 was chosen because it had characteristics similar to WMU 150, as did WMU 162 and WMU 163.

These modifications allowed for estimation of a simple conditional logit model using the RP survey data from the second year. The first model (CLRP1) contained the variables travel cost, CWD, and ASC 999 (an alternative specific constant for choices of WMUs outside of the study region). Both travel cost and ASC 999 had the expected sign and were statistically significant at the 1% level of significance; whereas, CWD did not have the expected sign and was not statistically significant. A model with additional explanatory variables was also estimated (CLRP2). This model included ASC200, ASC234, ASC236, the variable URBTC, which is the interaction of travel cost and those who live in an urban area, and the variable UCWD, which is the interaction of those who live in an urban area and CWD prevalence. Only the variable ASC234 was not statistically significant; UCWD was statistically significant at a 5% level of significance and the remaining variables were all statistically significant at a 1% level of significance. The sign of the travel cost variable was negative as expected, meaning that the hunters were negatively affected by further travel. Also, the sign on the interaction variable UCWD was negative, implying that the urban hunters were less interested in sites with CWD than rural hunters. Even though the UCWD interaction variable was negative and statistically significant, the main effect in this model was the variable CWD which was positive and larger than the urban interaction result. The interaction variable URBTC was positive and significant, which implied that urban hunters had a lower aversion to travel cost than rural hunters. The ASC's, with the exception of ASC234, all had significantly positive effects on choice, relative to the base, WMU 256. To a certain extent it is surprising that CWD appears to have a positive impact on site choice. CWD prevalence, however, is confounded with other factors including the management actions of culling and providing additional tags. Therefore, simple RP models like those presented here are not reliable in their representation of response to CWD.

Table 5-1. Parameter estimates from different conditional logit hunting site choice models estimated from 2008 Revealed Preference data.

Variable	CLRP1	CLRP2
CWD	0.0758 (0.0703)	0.3608** (0.1138)
TC	-6.6714** (0.7745)	-7.5118** (1.4271)
TAGS	-	-
CULL	-	-
URBTC	-	5.1319** (1.3227)
URBTAG	-	-
YRSCULL	-	-
UCWD	-	-0.2264* (0.0911)
TCDSP	-	-
ASC148	-	-
ASC150	-	-
ASC151	-	-
ASC162	-	-
ASC163	-	-
ASC200	-	1.4402** (0.3088)
ASC234	-	-0.3338 (0.4423)
ASC236	-	1.1492** (0.3160)
ASC 256	-	-
ASC500	-	-
ASC999	0.6784** (0.2126)	1.7448** (0.3237)
LLF	-436.4539	-417.173

B. Stated Preference Models for the 2008 Hunting Season

The analysis of the second year of SP data was approached in a similar fashion to the RP data; estimation of conditional logit models of increasing complexity. The initial estimation focused on the main variables, CWD, travel cost, TAGS, CULL, and ASC's with the exception of ASC500 which was used as the base of comparison for the other ASC's. CWD and travel cost were both negative and statistically significant at a 1% level of significance, which suggests that the hunters were negatively affected by CWD and travel costs. All of the ASCs had significantly positive effects on choice (relative to WMU 500). The variables TAGS and CULL, however, were both positive and not statistically significant.

The second conditional logit model included the variables from the initial estimation, and, included the interaction variables of: urban and travel cost (URBTC), urban and tags (URBTAG), as well as years of hunting experience and culling in the area (YRSCULL). The variables CWD and travel cost remain negative, as expected, and statistically significant at a 1% level of significance. The variables URBTAG and YRSCULL also had negative coefficients, which were statistically significant at a 1% level of significance. Urban hunters appeared to be adversely affected by the provision of tags, relative to rural hunters, and, where culling was present and a hunter had been hunting for a number of years, the hunter would be less likely to hunt in the area. The variables TAGS, CULL, and URBTC were all positive and statistically significant at a 1% significance level. Hunters were positively affected by the provision of tags, culling, and, urban hunters had a reduced aversion to travel cost. All of the ASCs continued to have significantly positive effects on choice, relative to ASC500.

The third conditional logit model used the same variables as in the second model, but with the addition of the interaction variable UCWD. In this model, the CWD variable became positive and no longer statistically significant. The ASCs continued to have a significantly positive effect on choice, relative to ASC500. The coefficients on the variables TAGS, CULL, and URBTC were all positive; however, only CULL and URBTC were statistically significant a 1% level of significance. These estimates suggest that hunters were positively affected by culling, while urban hunters remain less affected by travel cost. The coefficients of the interaction variables URBTAG, YRSCULL and UCWD were negative; however, only YRSCULL and UCWD were statistically significant at a 1% level of significance. Again, this model showed that hunters with many years of experience were less likely to hunt in an area where culling was present. The statistically significant negative UCWD variable indicated that urban hunters were adversely affected by CWD, relative to rural hunters who appear not to be affected by CWD.

Table 5-2. Parameter estimates from different conditional logit hunting site choice models estimated from 2008 Stated Preference data.

Variable	CLSP1	CLSP2	CLSP3
CWD	-0.0592* (0.0276)	-0.0695** (0.0269)	0.0514 (0.0524)
TC	-6.7098** (0.4724)	-13.0663** (1.2731)	-12.9834** (1.24487058)
TAGS	0.1156 (0.1158)	1.0260** (0.2211)	0.3684 (0.3415)
CULL	0.1134 (0.1002)	1.1941** (0.2052)	1.0718** (0.2111)
URBTC	-	8.0396** (1.2871)	8.2243** (1.2690)
URBTAG	-	-0.9653** (0.2243)	-0.2357 (0.3622)
YRSCULL	-	-0.0450** (0.0078)	-0.0422** (0.0079)
UCWD	-	-	-0.1346** (0.0502)
TCDSP	-	-	-
ASC148	1.7530* (0.7652)	1.8536* (0.7667)	1.7662* (0.7658)
ASC150	2.8092** (0.7501)	3.0880** (0.7538)	3.0848** (0.7503)
ASC151	3.7549** (0.7341)	3.9675** (0.7359)	3.9262** (0.7326)
ASC162	2.2841** (0.7300)	2.5006** (0.7311)	2.4510** (0.7307)
ASC163	2.4176** (0.7332)	2.6565** (0.7345)	2.5761** (0.7337)
ASC200	3.1546** (0.7192)	3.3190** (0.7209)	3.2452** (0.7199)
ASC234	3.7503** (0.7274)	3.2715** (0.7368)	3.1400** (0.7377)
ASC236	3.3555** (0.7175)	3.5712** (0.7193)	3.5212** (0.7185)
ASC 256	2.4785** (0.7314)	2.6461** (0.7335)	2.6371** (0.7326)
ASC500	-	-	-
ASC999	2.5941** (0.7324)	3.0281** (0.7352)	3.0273** (0.7344)
LLF	1426.497	-1383.772	-1380.137

C. **Combined Revealed Preference and Stated Preference Models for the 2008 Hunting Season**

The RP and SP data sets were next combined and examined using a conditional logit model. This model was estimated using the same vector of explanatory coefficients as the previous SP model, with the addition of a dummy variable for SP data which was interacted with the travel cost variable to create the variable TCDSP. In this model, CWD is positive but not statistically significant. The variable TAGS was negative but also not statistically significant. Finally, URBTAG which was positive was the only other variable that was not statistically significant. Travel cost was negative and statistically significant at a 1% level of significance, which showed that the hunters were negatively affected by travel cost. CULL was positive and statistically significant at a 1% significance level, which indicated that the hunters were positively affected by culling.

It was expected that the random utility errors associated with sites within the CWD region would be correlated because of unobserved factors that were similar between these sites, relative to sites outside the region. It was also expected that the error terms from the sites within the region would be less correlated (or uncorrelated) with the sites outside the region. Therefore, nested logit (NL) models were also estimated. Following Zimmer's (2009) approach, the study area was separated into those infected with CWD and those not infected with CWD (at the time of this study), which comprised the two branches of these estimations. The first NL model used the same vector of explanatory coefficients as the previous joint SP-RP CL model; however, the SP dummy variable, TCDSP was removed. The inclusive value (IV) parameter for the CWD branch was positive and statistically significantly different from 1 at a 1% level of significance, which would indicate that there were notable differences between the error correlations of the two nests. With the given data set, this has shown it was appropriate to group the CWD infected study area WMUs separately from those outside the area. The variable TAGS was positive but not statistically significant. In addition, the variable URBTAG, the interaction variable of the dummy variable for urban hunters and tags, was negative but not statistically significant. The ASCs all had positive effects on choice and were statistically significant at a 1% level of significance relative to WMU 500. CWD was positive and statistically significant at a 1% level of significance, which implied hunters were positively affected by CWD. The variable CULL was positive and statistically significant at a 1% level of significance, which suggests that the hunters were positively affected by culling. Travel cost was negative and statistically significant at a 1% level of significance, which implied the hunters were negatively affected by increased travel costs. The interaction variable URBTC is positive and statistically significant at a 1% level of significance, which implies that the urban hunters are less averse to increased travel costs. The interaction variable YRSCULL, which characterises the variable for the number of years a hunter stated they had been hunting for interacted with the dummy variable for whether or not there was culling in the area, was negative and statistically significant at a 1% level of significance, which would imply that an experienced hunter would be less likely to hunt in an area where culling was present. Finally, the variable UCWD, which represents the interaction between the dummy variable for urban hunters and CWD, was negative and statistically significant at a 1% significance level. This would indicate that the urban hunters are negatively affected by the prevalence of CWD, relative to rural hunters.

The second NL model included the variables from the previous NL model, with the inclusion of the interaction variable TCDSP. The results were consistent with the previous NL model with a notable exception, the interaction variable URBTAG continued to be negative, but became statistically significant at a 1% level of significance that would indicate that the urban hunters had an increased aversion to TAGS. The interaction variable TCDSP was positive and statistically significant at a 1% level of significance, indicating the possible existence of hypothetical bias in the stated preference data.

Table 5-3. Parameter estimates from different hunting site choice models estimated from 2008 joint Revealed Preference/Stated Preference data.

		Conditional Logit	Nested Logit	
Variable		CLRPSP1	NLRPSP1	NLRPSP2
CWD		0.0840 (0.0492)	0.2188** (0.0406)	0.2334** (0.0347)
TC		-14.6160** (1.1478)	-12.0635** (0.9771)	-13.1885** (1.0041)
TAGS		-0.1940 (0.2417)	0.2818 (0.2438)	0.4310 (0.2294)
CULL		0.5896** (0.1738)	0.7694** (0.1286)	0.5899** (0.0865)
URBTC		8.0765** (1.0869)	9.0891** (0.9869)	9.9084** (0.8895)
URBTAG		0.1915 (0.2608)	-0.3384 (0.2624)	-0.8936** (0.2374)
YRSCULL		-0.0284** (0.0065)	-0.0256** (0.0049)	-0.0119** (0.0028)
UCWD		-0.1893** (0.0446)	-0.1994** (0.0408)	-0.2292** (0.0349)
TCDSP		1.7528* (0.7265)	-	2.9248** (0.6352)
ASC148		1.6171* (0.7650)	2.3496** (0.7461)	1.0575* (0.4212)
ASC150		3.1787** (0.7487)	2.93800469** (0.7311)	1.7910** (0.4043)
ASC151		4.0214** (0.7321)	3.5007** (0.7192)	2.1382** (0.3743)
ASC162		2.3585* (0.7316)	3.1905** (0.7239)	1.6614** (0.3823)
ASC163		2.4216* (0.7341)	2.7505** (0.7313)	1.2989** (0.3986)
ASC200		3.1236** (0.7196)	3.4765** (0.7200)	1.80622241** (0.3720)
ASC234		3.2791** (0.7321)	2.8765** (0.7222)	1.6408** (0.3855)
ASC236		3.3781** (0.7187)	4.2629** (0.72001)	2.8635** (0.3739)
ASC 256		2.4451** (0.7327)	2.9850** (0.7343)	1.2601** (0.3999)
ASC500		-	-	-
ASC999		2.7673** (0.7332)	13.3381** (3.9856)	32.3928** (8.0739)
IV Parameters	No CWD	-	1 (fixed)	1 (fixed)
	CWD	-	2.9564** (0.6133)	8.3594** (1.5803)
LLF		-1893.751	-1846.032	-1840.968

D. Combined Revealed Preference and Stated Preference Models of Multi-Year Data

The first year of survey data was combined with the second year of survey data. Dummy variables were created to indicate stated preference data (DSP) and the second year of data (YR2). It was important to take into account the number of alternatives for each site choice because the second year of RP survey data had been simplified and reduced to 8 alternatives, from the initial 11, to create working RP models. Three conditional logit models were estimated with the multi-year data, each with increasing complexity. Finally, two nested logit models were estimated, similar to the NL estimations of the second year of SP survey data, where the study area was separated into those infected with CWD and those not infected with CWD, which comprised the two branches of these models.

Table 5-4. Parameter estimates from different hunting site choice models estimated from multi-year joint Revealed Preference/Stated Preference data.

	Conditional Logit			Nested Logit		
Variable	CL1	CL2	CL3	NL1	NL2	NL3 (HFN)
CWD	0.0134 (0.0125)	0.0139 (0.0129)	0.0072 (0.0131)	0.0402** (0.0112)	0.0371** (0.0117)	0.0348* (0.0135)
TC	-15.5207** (0.4418)	-15.9318** (0.4531)	-16.8712** (0.5180)	-15.3748** (0.4657)	-17.2636** (0.6150)	-22.231** (0.7608)
TAGS	0.4113** (0.0650)	0.5696** (0.0718)	0.5701** (0.0717)	0.4380** (0.0641)	0.5764** (0.0702)	0.5378** (0.0702)
CULL	-0.4605** (.07616)	-0.5930** (0.0825)	-0.5994** (0.08230)	-0.4385** (0.0751)	-0.5581** (0.0806)	-0.6454** (0.0853)
URBTC	7.1883** (0.4308)	7.0705** (0.4381)	7.1269** (0.4374)	6.8767** (0.4493)	6.8400** (0.4704)	7.9264** (0.5073)
URBTAG	-0.5009** (0.0840)	-0.4610** (0.0889)	-0.4514** (0.0886)	-0.4740** (0.0833)	-0.4268** (0.0876)	-0.3859** (0.0895)
YRSCULL	0.0119** (0.0029)	0.0105** (0.0030)	0.0105** (0.0030)	0.0118** (0.0030)	0.0104** (0.0031)	0.0138** (0.0034)
UCWD	-0.0636** (0.0129)	-0.0561** (0.0137)	-0.0622** (0.0137)	-0.0740** (0.0126)	-0.0733** (0.0133)	-0.0782** (0.0150)
TCDSP	-	-	1.3392** (0.3484)	-	1.6424** (0.4109)	4.6186** (0.5398)
D2TC	-	1.1936** (0.3300)	1.0827** (0.3321)	-	1.4639** (0.4321)	7.1791** (0.6073)
D2CWD	-	-0.0354* (0.0172)	-0.0343* (0.0171)	-	-0.0295 (0.0169)	-0.0064 (0.0172)
D2TAG	-	-0.4506** (0.1234)	-0.4431** (0.1227)	-	-0.4272** (0.1218)	-0.3011* (0.1184)
D2CULL	-	0.3589** (0.1116)	0.3580** (0.1111)	-	0.3276** (0.1100)	0.3697** (0.1112)

ASC148		3.8881** (0.1811)	3.9258** (0.1816)	3.8845** (0.1818)	0.8183** (0.1726)	0.7576** (0.1733)	0.9134** (0.1734)
ASC150		4.1386** (0.1955)	4.2059** (0.1982)	4.2489** (0.1987)	0.9561** (0.1720)	0.9670** (0.1750)	1.1160** (0.1854)
ASC151		4.6878** (0.1810)	4.7681** (0.1839)	4.8006** (0.1843)	1.4743** (0.1577)	1.4894** (0.1603)	1.6613** (0.1718)
ASC162		3.7028** (0.1710)	3.7636** (0.1716)	3.7280** (0.1717)	0.7859** (0.1616)	0.7443** (0.1615)	0.9384** (0.1635)
ASC163		4.1862** (0.1659)	4.2393** (0.1665)	4.1975** (0.1667)	1.1802** (0.1548)	1.1515** (0.1548)	1.3296** (0.1618)
ASC200		4.27690** (0.1583)	4.3061** (0.1590)	4.2840** (0.1589)	1.2812** (0.1489)	1.2233** (0.1491)	1.4088** (0.1536)
ASC234		4.7318** (0.1711)	4.8008** (0.1738)	4.8279** (0.1739)	1.5962** (0.1503)	1.5973** (0.1524)	1.7236** (0.1634)
ASC236		4.2925** (0.1520)	4.3525** (0.1526)	4.3334** (0.1526)	1.4351** (0.1488)	1.3935** (0.1489)	1.5645** (0.1542)
ASC 256		3.1101** (0.1734)	3.0952** (0.1740)	3.0607** (0.1742)	0.1941 (0.1701)	0.0916 (0.1713)	0.2471 (0.1720)
ASC500		-	-	-	-	-	-
ASC999		2.9152** (0.1410)	2.9152** (0.1410)	2.9152** (0.1410)	-0.1890 (0.1619)	-0.3261* (0.1557)	-0.7358** (0.1351)
IV Parameters	No CWD	-	-	-	1 (fixed)	1 (fixed)	1 (fixed)
	CWD				0.8591** (0.0511)	0.8052** (0.0560)	0.6237** (0.0445)
Co-variates in IV Parameters	YR2	-	-	-	-	-	-2.9349** (0.1808)
LLF		-7582.962	-7561.167	-7553.701	-7593.861	-7563.636	-7526.1663

a. Multi-Year Conditional Logit Models

The first CL model (CL1) included the variables for CWD, travel cost, tags, culling, ASCs (with the exclusion of ASC500 which continued to be the base choice), and the interaction variables: urban dummy and travel cost (URBTC), urban dummy and tag dummy (URBTAG), years of experience hunting and culling dummy (YRSCULL), and finally urban dummy with CWD (UCWD). All of the ASCs were positive and statistically significant at a 1% level of significance, which implies that the sites had a positive effect on choice relative to WMU 500. Travel cost had the hypothesised negative sign, and was statistically significant at a 1% level of significance. This again indicated that the hunters, overall, were negatively affected by increased travel costs. Hunters, in general, were positively affected by the provision of tags as indicated by the positive coefficient and statistical significance at a 1% level of significance. The variable for culling was negative and statistically significant at a 1% level of significance, which indicates that the hunters were negatively affected by culling. The variable CWD was positive but not statistically significant. The interaction variable, URBTC, was positive and statistically significant at a 1% level of significance. This was consistent with the notion that urban hunters have a reduced aversion to increased travel costs. The remaining urban interaction variables, URBTAG and UCWD, were both negative and statistically significant at a 1% level of significance. This indicated that urban hunters were negatively affected by the provision of tags and the prevalence of CWD. The interaction variable YRSCULL was positive and statistically significant at a 1% level of significance, which suggests that the more years of experience a hunter had accumulated and if culling was present, the hunter would be more likely to hunt in that area.

In the second CL model (CL2), the same vector of explanatory coefficients was used as in the preceding model, with the addition of a dummy variable for the second year of data. The dummy variable, which indicated that the data were from the second year, was interacted with travel cost (D2TC), CWD prevalence (D2CWD), tags (D2TAG), and culling (D2CULL), to help highlight potential differences in hunter behaviour between the two years of data. The second CL model produced results that were consistent with those from the first CL model. The interaction variables introduced to show differences between the two years of data produced insightful results. The variable D2TC, was positive and statistically significant at a 1% level of significance. This indicates that hunters from the second year are less averse to increased travel cost, which could signify a change in costs that were not reflected in the travel cost calculation, a change in the sample composition which includes people who have less aversion to travel, or a change in preferences. Also, there may have been changes gas prices, or perhaps the weather was better making it easier to travel long distances. The variable D2CULL was also positive and statistically significant at a 5% level of significance. This suggests that the hunters from the second year were more interested in hunting at sites with culling than hunters from the first year. This could be due to hunters in 2008 feeling that the Alberta Government culling program, aimed to reduce the spread and prevalence of CWD, was effective. Choosing a WMU with culling, one would expect a decreased deer population density, and therefore decreasing the risk of bagging a deer infected with CWD. The interaction variable, D2TAG, was negative and statistically significant at a 1% level of significance, which would indicate that hunters in the second year were more negatively affected by the provision of tags relative to the hunters in the first year. Finally, the variable D2CWD was also negative and statistically significant at a 1% level of significance showing that hunters in the second year were more negatively affected by the prevalence of CWD relative to hunters in the first year. This finding is consistent with the descriptive statistics presented in the previous chapter, which showed increased concern among hunters from the second year.

The third CL model (CL3) expanded on the previous model by adding a dummy variable for SP data, to help determine whether SP responses differed significantly from RP responses. The dummy variable for SP data was interacted with travel cost to create the variable TCDSP. Again, all the variables present in the preceding model had results that were consistent with the previous estimates. The interaction variable TCDSP was positive and statistically significant at a 1% level of significance. This indicates that within SP data, there was a reduced aversion to increased travel; this is consistent with theory since in a hypothetical situation, respondents tend to underestimate their response to travel cost.

b. Multi-Year Nested Logit Models

Next, NL models were attempted, with the same nesting structure as in the case of combined RP and SP NL models reported above. The expectation was that error terms from sites within the CWD region would be correlated relative to those outside the region across the two years of data.

The first NL estimation (NL1) used the same vector of explanatory variables as CL1, that is: CWD, travel cost, TAG, CULL, URBTC, URBTAG, YRSCULL, UCWD, and the ASCs (again with the exception of ASC500, which is used as the base case). In general, the results are consistent with those in the CL model, with a few notable exceptions. In the NL model, CWD is positive and statistically significant at a 1% level of significance. This is contrary to the hypothesised sign, and indicates that rural hunters have been positively affected by the prevalence of CWD. Perhaps this finding was due to decreased congestion at CWD positive hunting sites within the study area, or, that there remains collinearity in the data that results in the CWD variable being confounded with other factors. The coefficient for ASC256 remained positive but was no longer statistically significant, while the coefficient on ASC999 was negative but not statistically significant. The inclusive value (IV) parameter for the CWD branch was positive and statistically significantly different from 1 at a 1% level of significance, which would indicate that there were notable differences between the error correlations of the two nests. With this merged data set, these estimates have shown it was appropriate to group the CWD infected study area WMUs separately from those outside the area.

The second NL (NL2) estimation used the same vector of explanatory variables that was used in the model CL3. In addition, the following explanatory variables were considered: TCDSP, D2TC, D2CWD, D2TAG, and D2CULL.

The results were consistent with the findings from the NL1 model; the signs and statistical significance were the same between the two cases. The interaction variable TCDSP was positive and statistically significant at a 1% level of significance; this would imply that hunters in hypothetical situations have a reduced aversion to increased travel and underestimate their response to travel cost. This finding is consistent with the CL3 estimation. The interaction variable D2TC was positive and statistically significant at a 1% level of significance; this indicated that hunters from the second year had a reduced aversion to increased travel. The explanatory variable D2CWD was negative, however, not statistically significant. The variable D2TAG was negative and statistically significant at a 1% level of significance. This indicated that the respondents from the second year are negatively affected by the provision of tags relative to the respondents from the first year; this finding is also consistent with the results from the CL3 model. Finally, the D2CULL variable was positive and statistically significant at a 1% level of significance, which indicated, as in the 3rd CL model, that the hunters in the second year reacted positively to the culling program relative to the hunters from the first year. The inclusive value (IV) parameter for the CWD branch was, again, positive and statistically significantly different from 1 at a 1% level of significance, which indicated that there were notable differences between the error correlations of the two nests. With two years of survey response data merged, this model has shown it was appropriate to group the CWD infected study area WMUs separately from those outside the area.

The model CL3 was very similar to model NL2. To determine the preferred model a likelihood ratio test was conducted.

D = -2[ln(likelihood for null model) – ln(likelihood for alternative model)]

D= -2[7553.701 – 7563.636] ≈ 19.87 with 1 degrees of freedom

The test statistic D, which has an approximate chi-squared distribution, statistically significant at a 1% level of significance and therefore we reject the null hypothesis that the non-nested model is statistically the same as the nested model.

The last model estimated was NL3 (HFN), which used the same explanatory variables as NL2, but with the addition of the dummy variable for the second year of data (YR2). This allowed the dummy variable for the second year of data to be used as a variable explaining the variance components in the nested logit structure, to show whether the source of the difference between year one and year two is associated with preferences or the scale/variance of the error component. It is important to consider covariance heterogeneity within nested alternatives to decrease the potential for biased and inconsistent estimation. The results of the explanatory variables are consistent with the NL2 estimation. The variable YR2 is negative and statistically significant at a 1% level of significance. This showed that the year two variable is significant in the co-variance heterogeneity component. This indicates that the second year of data has a different error variance structure, which can be interpreted as evidence that the variance of the error of utility is changing between years one and two. In other words, hunters appear to be more systematic in their hunting site choices in year 1 relative to year 2.

E. Application of Results – Welfare Measurement

This section discusses how the multi-year NL model was used to predict behavioural outcomes and measure the economic welfare impacts to changes in CWD. These predictions help to provide an understanding of how hunters are affected by CWD and how their behaviour is shaped by their perception of CWD. To determine the efficiency of the management programs and the consequences of CWD, worst case scenario simulations and welfare analyses were calculated.

a. Scenarios

This study compares a worst-case scenario to the current situation for both an average urban respondent and an average rural respondent from each year of data for the purpose of welfare calculations. The worst-case scenario, developed by Zimmer (2009 p59), constituted the highest potential CWD spread and prevalence situation if the disease was not prevented in any manner by management policies. The welfare calculation, for the dollars per trip per hunter, in this study was particularly sensitive to the model specification; therefore, only the prevalence of CWD was varied while the management policies were held constant between the two scenarios. The respective variable levels are presented in table 5-5 below.

Table 5-5. Proposed worst-case scenario used to calculate welfare measures. These levels were current at the time of the survey.

	Current Management			**Worst Case Scenario**		
WMU	*CWD*	*TAGS*	*CULL*	*CWD*	*TAGS*	*CULL*
148	0	No	No	7.5	No	No
150	2.5	Yes	Yes	12.5	Yes	Yes
151	2.5	Yes	Yes	12.5	Yes	Yes
162	0	No	No	7.5	No	No
163	0	No	No	2.5	No	No
200	0	No	No	7.5	No	No
234	2.5	Yes	Yes	12.5	Yes	Yes
236	0	No	No	7.5	No	No
256	0	No	No	2.5	No	No
500	0	No	No	7.5	No	No
999	0	No	No	2.5	No	No

b. Welfare Calculations

Welfare measures provide a monetary estimate of how much respondents would be willing to pay to remain at their original utility level. Using the results from NL2 model (excluding the TCDSP interaction term), from the previous section, the amount of money per average hunter per trip was calculated to determine how much they would be willing to pay to remain at current management scenario. The values are displayed in Table 5-6 and were calculated using equation 3.19. Given that the calculations use joint RP/SP data, the welfare measures may therefore overestimate the actual amount that a given respondent would be willing to pay.

Table 5-6. Willingness to pay for avoiding the worst-case scenario with increased CWD prevalence within the study area.

	$ per trip per hunter		*$ per hunter per year**		*$ for the Province of Alberta per year***	
	Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Year 1	$1.09	-$0.68	$5.43	-$11.54	$42,129.23	-$89,581.15
Year 2	$2.64	-$0.35	$13.19	-$6.00	$102,370.30	-$46,555.69

*Calculated by multiplying per trip per hunter measure by the average number of trips for both urban and rural hunters across both years.
**Calculated by multiplying the per hunter welfare measure by the reported number of hunters in the study region in 2006 (7764) from Alberta Sustainable Development (Zimmer 2009 p65).

The highest welfare measure obtained was from urban hunters from the second year of data, $2.64 per trip. The urban respondents in 2008 would be willing to pay this amount to avoid the situation with increased spread and prevalence of CWD; therefore, these urban hunters prefer the current situation over the hypothetical scenario of increased spread and prevalence. Similarly, urban respondents in 2007 would be willing to pay $1.09 to maintain the current situation over the hypothetical worst-case scenario. The $ per trip per hunter welfare measures are relatively small, future work regarding welfare measures related to CWD should include calculating the variances to determine if the welfare measures are significant.

According to Haab and McConnell (1997), in many cases of public goods negative willingness to pay values can be ignored if they provide nothing of use to the given respondent; for cases where people object to a given scenario and there is no cost associated to it a negative willingness to pay would be consistent with a willingness to accept compensation. Rural respondents from 2007 appear to be made better off from the hypothetical scenario with increased spread and prevalence of CWD, and would be willing to accept approximately $0.68 per trip to maintain the current scenario. Similarly, rural respondents in 2008 would be willing to accept $0.35 per trip to maintain the current scenario.

In both years urban respondents would be willing to pay to maintain the current levels and prevalence of CWD, while the rural respondents would require compensation to remain in the current situation relative to the hypothetical one. Respondents from both years appear to be quite heterogeneous, and the welfare measures can vary widely for each demographic in the study.

Aggregating welfare measures to the provincial level assesses the impact of CWD on hunters. This was computed by multiplying the average number of trips taken by urban and rural hunters in both years of the sample by the per hunter welfare and the recorded number of deer hunters in the study area for 2006 (Zimmer 2009 p67). By aggregating to the provincial level a simple cost-benefit analysis of the CWD management program can be computed. Pybus (2007) reported that the total cost for the 2006 winter CWD program was approximately $1,080,000 (p2). These costs included culling but not the diagnostic cost for testing for CWD. A cost not accounted for in this report was the mandatory head testing program for hunters. A simple cost-benefit analysis would "examine the costs of the program and the benefits associated with reduced CWD levels with the program versus those without the program" (Zimmer 2009 p67) and depends on the expected outcomes of the program.

While Zimmer's calculations for WTP to avoid the increased spread and prevalence with all of the WMUs affected was approximately $9.68 per trip per hunter, this study found the WTP to avoid the increased spread and prevalence was approximately $1.09 trip per hunter for urban hunters in 2007, $2.64 trip per hunter for urban hunters in 2008, -$0.68 trip per hunter for rural hunters in 2007, and -$0.35 trip per hunter for rural hunters in 2008. These differences could be due to differences in variables in the nested logit models used to calculate the WTP. Alternatively, the welfare calculations in this study were particularly sensitive to the model specification; therefore, only the prevalence of CWD was varied while the management policies were held constant between the two scenarios, while in Zimmer's (2009) study assumed there were no management policies in use. The welfare calculations in this study specifically address a change in the prevalence and spread of CWD holding all other variables constant. As seen in Figure 4-1, many respondents in 2008 were taking hunting trips outside of the study region. This could also explain why increasing CWD spread and prevalence within the study region does not have the same impact on welfare calculations as it did in Zimmer (2009).

F. <u>Summary</u>

The behavioural choice model chosen for the fusion of RP and SP data, from the second year of the study, was the non-nested conditional logit model which included WMU ASCs, four attributes, and five interaction variables. The interaction of travel cost and the dummy for stated preference data was positive and statistically significant, which suggests some form of hypothetical bias.

The behavioural choice model preferred when the two years of data were fused was a two-level nested logit that divided the alternatives into WMUs from within the study area and WMUs outside of the study area, where all but two parameters are statistically significant. The multi-year choice model also appears to suffer from hypothetical bias, as did the 2008 choice model.

Using the multi-year estimation results and a worst-case scenario, welfare measurements were calculated. The welfare calculations demonstrated that the urban hunters, in both years, would be made worse off in a no management scenario with increased CWD spread and prevalence, relative to the current situation. Rural hunters, in both years, would be made better off by a no management situation with increased CWD spread and prevalence, relative to the current situation. This result could arise from rural hunters' perceiving less congestion at hunting sites as urban hunters hunt outside of the study area or change the species which they hunt; indicating that CWD preferences and congestion preferences are confounded making it difficult to isolate the impact of CWD.

CHAPTER 6 – SUMMARY

A. Summary

This two-year study, in the province of Alberta, has attempted to answer questions regarding CWD and hunting behaviour, such as: how does the prevalence of CWD affect hunter site choice and how does this affect hunters in terms of economic welfare? CWD was relatively new in Alberta during the two-year study period and the effect on hunters was not well understood and there was little literature examining questions of this nature. Thus this study also attempted to assess the change in views on CWD over the two year period and the impact on economic values.

The study area, comprised of 10 WMUs, was located along the Eastern to South-Eastern border of Alberta. These WMUs were chosen due to prior existence of CWD in some areas and the potential for CWD spreading to others. Respondents, randomly selected using the hunting licence database, completed an online questionnaire, with both qualitative and quantitative questions regarding their hunting behaviour and beliefs regarding CWD. There were three contingent behaviour questions presented which consisted of scenarios, for each WMU in the study area, with varying levels of CWD prevalence along with the presence or absence of extra tags or culling. Respondents who participated in the 2007 study were able to participate again in the 2008 study, though not all did.

When the data from 2007 and 2008 were combined, the two-level nested logit that divided the alternatives into WMUs from within the study area and WMUs outside of the study area became the preferred model. All but two of the parameters were statistically significant. The parameter for the prevalence of CWD was positive and statistically significant for rural respondents. This was contrary to the hypothesised sign, which would indicate that hunters have been positively affected by the prevalence of CWD. Perhaps the rural hunters are viewing higher CWD levels as decreased congestion, or perhaps these CWD values are still correlated with culling and tags, which both positively affect rural hunters. Whatever the reason, rural hunters are not averse to CWD. The urban hunter and CWD interaction variable was negative and statistically significant. There was a disproportionate representation of urban hunters in the study and they were shown to have a negative response to CWD relative to rural hunters. The alternative specific constant for WMU 256 was positive but not statistically significant, while the interaction variable for the prevalence of CWD and the dummy variable for year two was negative but not statistically significant. It was shown that in hypothetical situations, hunters had a reduced aversion to increased travel cost and tend to underestimate their response to travel cost.

Hunters from 2008 were negatively affected by the provision of tags relative to respondents from 2007, while hunters from 2008 reacted positively to the culling program relative to hunters in 2007. The interaction between urban and the provision of tags was negative, which illustrated that urban respondents were less interested in additional tags relative to rural respondents, while the interaction of years previously hunted and the presence of culling was positive, which demonstrated that with greater hunting experience there was more support for the culling program. When the data from 2007 and 2008 were fused, there was again evidence of hypothetical bias, because the interaction variable of travel cost and the SP dummy variable was positive and significant.

These models utilized both the revealed preference (RP) and the stated preference (SP) data. To identify potential econometric issues, it was important to examine preferences within the RP and SP data sets individually. RP data from 2008 lacked variation in certain variables while no trips were taken to certain WMUs. The lack of variation among independent variables for this type of RP data is common; there was a high collinearity between management programs and the prevalence of CWD. To obtain simple working conditional logit RP estimations for the 2008 data set, some simplifications were made, such as combining WMUs with few trips taken with other WMUs with similar characteristics. Though simple RP models were estimated, they would not be reliable in their representation of respondent response to CWD. Choice models of the 2008 SP data converged without having to make the modifications necessary for the 2008 RP data. The more robust data set allowed for the creation of interaction variables.

Taking the results gathered from the estimations, economic welfare calculations were performed to make the information more applicable to management. Utilizing the average rural and urban respondent from both 2007 and 2008, the worst-case scenario, developed by Zimmer (2009), was compared to the current situation and management practices at the time of the study. Next, a monetary measure was computed for the average rural and average urban respondent from both years of the study, to determine what they would be willing to pay to maintain their current situation and to maintain their same associated level of utility. Multiplying these results with the average number of trips for both urban and rural hunters across both years and then the number of hunters to the study area, total welfare impacts for Alberta were determined.

These results show that there are apparent differences between the preferences arising from data obtained in 2007 and the data obtained in 2008. Overall, it would appear that respondents, especially urban respondents, in the second year are more risk averse, relative to the first year. This could be due to changing preferences/perceptions and behaviour, or that respondents in the second year are more likely to be individuals more concerned about CWD or deer populations and who have submitted questionnaires in the second year. The model NL3, similar to the preferred multi-year model but with the addition of a dummy variable to account for the second year of data, demonstrated that there the variable for 2008 is significant in the co-variance heterogeneity component. This indicates that the second year of data has a different error variance structure, and provides evidence that the variance of the error of utility is changing between years one and two. In other words, hunters appear to be more systematic in their hunting site choices in year 1 relative to year 2.

B. Caveats

In 2007 there were only 24 rural respondents of a total 90 respondents, while in 2008 there were only 3 rural respondents of a total 40 respondents. This relatively low number of rural respondents may not be totally representative of the individuals who live in a rural location and hunt within the study area. When analyzing the differences between urban and rural respondents and their related behavioural responses, the results have the potential to change given a greater number of rural respondents. The relatively small sample size in 2008, especially that of rural hunters, may not be as skewed as the number of hunters may at first indicate. The models estimated in this study were all based on trips taken, so the percentage of trips by rural respondents would not be as skewed as the number of rural respondents relative to urban respondents.

In 2008, only 40 of the 90 hunters from 2007 responded to the second survey. This made for a notably smaller sample size for the second year of data. Urban respondents were selected from winners, in Edmonton and Calgary, of a lottery-rationed mule deer draw. The probability of winning the same draw in the subsequent year is assumed to be quite small. Urban respondents who participated in the 2007 study may not have been able to hunt within the same WMU or study region again in 2008. This may have affected the response rate of urban hunters in 2008, which had a notably smaller sample size relative to 2007. Urban hunters appeared to have shifting perceptions of CWD related risk. This may have been due to increased information availability, and/or, the potential to substitute hunting in non-CWD infected WMUs rather than hunting in CWD infection sites.

When pooling the data from 2007 and 2008, the 90 respondents from the first year were pooled with the 40 respondents from the second year. It could potentially be more useful to see how the 40 respondents from 2008 differed in their responses and trip behaviour from 2007. In this study it was not possible to explicitly track these 40 respondents between 2007 and 2008.

While the respondents of this study theoretically represent the hunters that hunt within the study region, it is not representative of hunters everywhere. In other regions, there may be different CWD management practice in use and hunters in these areas could have different views regarding CWD that would alter their behavioural response that could generate dissimilar results. A larger overall, sample size might have improved or altered the results in some fashion. While rural hunters were selected from the whitetail deer licence database, these licences can be used anywhere within Alberta; so, rural respondents to the survey had an increased probability of living within a reasonable proximity to the study area. Using the mule deer draw licence database to select urban respondents may have introduced some bias into the results. Those who enter the draw and win could have a greater interest in that area, and have a unique subset of characteristics, which would decrease the overall representativeness of the sample.

The questionnaire for this study required that it be completed electronically. It was hypothesised that this would not be an issue for urban respondents, but could pose a problem for rural respondents who may not have easy access to computers or internet access; therefore in 2008, sessions were held in rural locations where both computers and researches were available; there was only one rural respondent who utilized this service. Either technology has become more prevalent in rural Alberta than originally thought or rural respondents did not want to complete the survey electronically.

Zimmer (2009) identified potential hypothetical bias using RP and SP comparisons for the 2007 data. For the 2008 data and the multi-year data, there was an indication that there was some form of hypothetical bias within the SP data through the interaction variable for travel cost and the SP dummy. Inaccurate coefficients could potentially produce distorted welfare measures. Zimmer (2009 p56) demonstrated that the hypothetical bias in this study is suspected to be small and does not significantly affect the results.

Although the choice model may be a best fit for the data in this particular study, it may not be the best for estimating these behavioural choices. Given that this study used panel data, the nested logit structure would not completely capture the panel structure. Potentially, with more data and therefore more variation a different modeling approach could better represent the data structure better, such as latent class models or random parameter models.

While this study has described differences in coefficients between years as preference changes it is not clear whether these are changes in hunter preferences or changes in information sets. As information about CWD changes hunters may form different perceptions of the risks of the disease and change their hunting behaviour.

C. <u>Application to Management</u>

The Government of Alberta discontinued their CWD winter control program after the 2008 hunting season. Though hunter and management strategies may not always coincide, it would be advisable to have a firm understanding of involved hunter activities, demographics and characteristics, because there may be unexpected behavioural responses to management strategies. The data in this study revealed that while culling had an overall negative impact on hunter preferences for site choices within the study area; it appeared to be a more acceptable management strategy among more experienced hunters. Similarly, while the provision of extra tags had an overall positive affect on site choice within the study area, it appeared to be a less acceptable management strategy among urban respondents relative to rural respondents.

The welfare measures calculated in this study show that the current situation is preferred to one with increased spread and prevalence among urban hunters in both years of the study. The welfare measures could shift given a sample with a more representative rural hunter population. For this study, there were 24 rural hunters in 2007 and 3 rural hunters in 2008 and the welfare measures computed for rural hunters may not be very representative and would make provincial level cost-benefit analysis difficult. And while not directly measured in the welfare calculations, an increase in the spread and prevalence of CWD could have a negative economic impact in terms of expenditures in rural hunting areas.

D. <u>Future Research</u>

There is a variety of ways to extend and build upon this study. While in this particular study, there were a limited number of respondents in both 2007 and 2008, re-implementing this study with an increased number of respondents would be an opportunity to enrich the results and gain understanding of behavioural responses. Completing this study again would also allow for further multi-year comparisons and behavioural changes over time.

While this study focused on hunting in the Eastern portion of Alberta, this study could be applied to similar areas where CWD is found such as in Saskatchewan and portions of the United States. Management programs could differ by region, but the welfare and behavioural impacts would be reflected with such changes. Implementing a comparable study in other areas would help define the values of hunters and various programs that they support. Gathering deeper understanding of hunting behaviour and response in related areas would help increase knowledge of CWD, who is affected by CWD, and encourage co-operation between governing institutions.

Future research could explore a more thorough cost-benefit analysis, through determining a detailed summary of CWD management strategies; this would help estimate future costs, and enhance the precision of analysis. Additionally, expanding the knowledge of the multiplier effect of money spent in rural Alberta could aid in analysis and increase precision of estimates and resulting impacts.

E. <u>Conclusion</u>

Prion diseases, such as CWD, are particularly challenging to study largely because they are not fully understood. While there are still questions surrounding the disease, it becomes inherently complicated to develop strategies aimed at management. With the uncertainty that still surrounds CWD, multi-year data sets are very useful to help identify changes overtime; however, many challenges arise when collecting such a data set. Despite the problems facing researchers, governing bodies have been actively seeking to try to control CWD, aiming to reduce the spread of the disease and its prevalence. Alberta hunters' support, to varying degrees, reducing the spread and prevalence of CWD through the management strategies implemented at the time of this study. Although hunters engage in hunting for a variety of reasons, ranging from experiencing nature to connecting with family and friends to harvesting a deer, the overarching goal is to protect the sport for both current and future generations. Continuing studies, such as this one, will help expand the pool of knowledge from which management strategies and programs are developed.

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Appendix A – Survey

Deer Hunting in Alberta:
Priorities and Preferences

UNIVERSITY OF ALBERTA

Department of Rural Economy
515 General Services Building
University of Alberta
T6G 2H1

Dear Respondent:

Alberta's wildlife resources are abundant and diverse. They are also very important for a variety of recreational activities and support a large array of interests and industries. Ensuring continued use of these resources now and in the future is done through informed wildlife management. This survey is one way in which information can be gathered to improve wildlife management and better determine the impacts that stem from interests which utilize the wildlife resources.

This survey will be asking questions about deer hunting preferences and practices within the province. The answers you give in this survey will be used to improve understanding of deer hunting and the importance of it to the province as a whole. The answers will also allow current facts to be updated so policy makers can have a more accurate picture of hunting.

Thank you in advance for answering the following questions. Please be aware that all your responses are completely confidential. Individual responses will not be shared with anyone outside the research team. Only aggregate results will be presented in reports.

The entire survey is computerized and all your responses will be recorded through a computer. Please take the time to read all the questions and answer them as best you can. There are helpers present to assist you if there are problems, so feel free to ask if you have any questions.

Thank you again for your time and participation in this project!

Sincerely,
Department of Rural Economy Research Team

The following questions are meant to collect information regarding your deer hunting trips taken in Alberta and your opinions about wildlife resources in Alberta. Your answers will help us to understand preferences for hunting and create better wildlife management decisions.

How many years have you been deer hunting for? ___________

Did your family hunt deer while you were growing up? Yes No

Which weapon(s) do you hunt deer with? Please circle all that apply.

Rifle Cross bow Bow and arrow Shotgun Muzzleloader

Have you ever taken a hunting training course? Yes No
If yes, how old were you when you first completed it? __________

What land do you typically hunt deer on in Alberta?
Private Crown Both

What WMU would you list as your favourite WMU to hunt deer in?
____

Have you hunted deer outside the province in the last five years?
Yes No

Have you hunted deer outside the country in the last five years?
Yes No

Please rate the following statements about quality deer hunting attributes on a scale of 1 (Not Important) to 5 (Very Important).

	Not Important		Indifferent		Very Important
Seeing deer and interacting with wildlife.	1	2	3	4	5
Having the thrill of hunting/adventure	1	2	3	4	5
Harvesting a deer	1	2	3	4	5
Having a relaxing and restful time	1	2	3	4	5
Harvesting a trophy buck	1	2	3	4	5
Harvesting a doe/fawn	1	2	3	4	5
Just being outside and close to nature	1	2	3	4	5
Being far away from a city/town	1	2	3	4	5
Not seeing any other hunters and not being disturbed	1	2	3	4	5
Having time to myself	1	2	3	4	5
Good access to the hunting area (e.g. paved roads, 2WD access)	1	2	3	4	5
Making use of my outdoor/hunting skills	1	2	3	4	5
Close proximity to a cabin or lodge to which I have access thereby allowing day hunting trips	1	2	3	4	5
Familiarity with the hunting area	1	2	3	4	5
Bringing food home	1	2	3	4	5
Spending time with my family and friends	1	2	3	4	5

If for some reason you could not hunt deer next season in your usual hunting area(s), what would you do instead? Please circle all that apply.

a) Hunt deer in another area(s) in Alberta
b) Hunt other species but in the same areas
c) Hunt other species in another area
d) Hunt deer outside the province
e) Go camping
f) Engage in wildlife viewing/hiking/photography
g) Go fishing
h) Play indoor sports
i) Stay at home

Now, out of the reasons chosen above, which one would be the most important alternative?

____

Think of the deer hunting trips you participated in during 2007.

Please estimate your expenditures in the following areas for that trip. A trip involves travel to and from a hunting site, and may involve one or more days at the site. Please provide an estimate of how much you spent in total for each category, and, approximately, the percentage (%) of the total that you spent on location, in the WMU(s) (i.e. the hunting areas(s)).

Money qualifies as being spent in the hunting area if only it was paid to a local person/business for a good/service procured while in the hunting area.

- If you split the cost of the trip with other people, please give the amount *you personally* spent.
- If you spent nothing in a category, please put a 0 in the total amount cell.
- If you cannot find the appropriate category for your expenditure, use the "Other" category and specify what kind of expenditure it was.
- If you bought a package with everything included, please indicate the amount of the package under "Other." If there were additional expenditures, beyond the package, in any of the categories, please indicate how much they were; otherwise just write $0 for each of them.

Expenditure category	Total amount	Percentage (%) spent in hunting region
Gas for vehicles (including ATVs)	___________	___________
Accommodations (e.g. RV rentals, camping fees, motels)	___________	___________
Guiding fees	___________	___________
Food and beverages (e.g. restaurants, groceries, liquor stores, etc.)	___________	___________
Equipment for hunting (including ammunition, clothing, and camping supplies if necessary)	___________	___________
License fees	___________	___________
Butchering (including cutting and packaging)	___________	___________
Other (please specify) _____________	___________	___________

In this next section we ask you to recall hunting trips that you personally took on during the past two years. Please recall as much information as possible and be as specific as possible. There are calendars available if you wish to look at them to help you remember specific dates. Each piece of information asked of you is explained below.

Please complete the following tables for each hunting season. You are asked to indicate the following:

1. Please write down the closest town/city or landmark where you hunted. For example, you could write down, Battle River near the Saskatchewan border or Paradise Valley. If you hunted in various places in the WMU, please choose a town or landmark most central to all the areas hunted in, or the most commonly visited area where you hunted.

2. This is the overall number of trips made to that WMU during the entire hunting season. Please note that if there were multiple destinations or overnight trips, the number of trips to that WMU may not equal the number of days spent there. A trip is defined as travel to and from a hunting site and may involve one or more days at a site.

3. The total nights stayed would only be applicable for overnight trips. If only day trips were made to that WMU, place a 0 in that column.

4. Please indicate how many years you have previously hunted in that WMU. If this is your first season hunting there, the number should be 0.

5. This would be the total number of days spent in that WMU for the entire season. Please think of the number of trips you took and how long you spent there.

Example:

Please complete the following table for each deer hunt you went on during the 2007 hunting season.

WMU hunted in	Number of trips to the WMU	Nearest landmark or town to where you hunted	Total nights stayed on location	How many years have you previously hunted in this WMU?	Total number of days
148	0		0	0	0
150	0		0	2 years	0
151	5	Empress	6	1 year	11
162	0		0	0	0
163	0		0	0	0
200	0		0	0	0
234	0		0	0	0
236	0		0	0	0
256	3	Marwayne	1	10 years	3
500	0		0	0	0
Please indicate any other WMUs you hunted in.					
164	1	Coronation	1	5 years	2

Please complete the following table for each deer hunt you went on during the 2007 hunting season.

WMU hunted in	Number of trips to the WMU	Nearest landmark or town to where you hunted	Total nights stayed on location	How many years have you previously hunted in this WMU?	Total number of days
148					
150					
151					
162					
163					
200					
234					
236					
256					
500					
Please indicate any other WMUs you hunted in.					

In this section we are trying to determine what is important to you during hunting trips and how the presence of wildlife disease may affect your hunting decisions. Please read all the information presented first and then answer the questions accordingly.

Please read the following information about chronic wasting disease.

Chronic wasting disease (CWD) is a disease caused by prions which are infectious proteins that cause small lesions and the sponginess of the brain. It is a similar disease to mad cow disease in cattle and scrapie in sheep.

The animal will exhibit significant weight loss over a period of time, lowering of the head, walking in a repeated pattern, excessive drooling and grinding teeth, and decreased relationships with other animals.

It is not currently known how CWD spreads. The disease is likely transferred through animal to animal contact although this has not been scientifically confirmed. It is very resistant to environmental conditions such as direct sunlight or rain, and therefore the disease can exist in a contaminated area for quite awhile.

Currently, there is no cure for CWD. This disease is limited to infecting cervids: deer, elk, and moose. No cases have been reported of CWD transferring to livestock. While the possibility of transmission to humans is a concern, it is important to note that there have been no verified cases of humans contracting CWD.

For safety's sake, hunters are still told not to eat the meat of the infected animal and to take precautions when handling the carcass of a potentially infected animal.

Had you heard of CWD before you received this survey?

Yes No

Do you feel CWD is a threat to wildlife herd health in Alberta?

a) Yes, I feel it is a threat.
b) I feel it is present but is not currently a threat.
c) No, I feel it is not a threat.
d) I am not sure or I need more information.

Do you feel CWD is a threat to human health?

a) Yes, I feel it is a threat.
b) I feel it is present but is not currently a threat.
c) No, I feel it is not a threat.
d) I am not sure or I need more information.

What do you think CWD will do to deer hunting in the province of Alberta over the next 10 years?

a) The amount of hunting will decrease.
b) The amount of hunting will increase.
c) The amount of hunting will be unchanged.
d) I am not sure or I need more information.

If there was an additional extended season in October for hunting in CWD infected areas, would you participate?

Yes No

Currently the government is conducting a variety of programs to address CWD in the province of Alberta. Please rate your satisfaction with these programs on a scale of 1 (Very Dissatisfied) to 5 (Very Satisfied).

	Very Dissatisfied		Indifferent		Very Satisfied
Culling of herds in the areas where CWD is most concentrated.	**1**	**2**	**3**	**4**	**5**
Mandatory submission of heads to Fish and Wildlife for testing in certain WMUs.	**1**	**2**	**3**	**4**	**5**
Voluntary submission of heads for the province.	**1**	**2**	**3**	**4**	**5**
Materials for educational purposes placed on Sustainable Resource Development's website.	**1**	**2**	**3**	**4**	**5**
Open public meetings to discuss CWD.	**1**	**2**	**3**	**4**	**5**
Mailouts and advertisements in local newspapers.	**1**	**2**	**3**	**4**	**5**
Provisions of freezer locations for deer head submission.	**1**	**2**	**3**	**4**	**5**
Providing additional quota deer licenses in certain WMUs when heads are submitted for testing.	**1**	**2**	**3**	**4**	**5**
Research of the prion, its properties, and the disease itself.	**1**	**2**	**3**	**4**	**5**

Indicate using the scale of "Strongly disagree" to "Strongly agree" your agreement with the statement by checking on one of the lines:

"Obtaining knowledge of these programs can be done relatively easily."

[Strongly disagree] __ __ __ __ __ [Strongly agree]

We would like to know how extensive and how serious you think CWD currently is in the wild deer population in certain areas of Alberta.

Please complete the chart below for each WMU provided. Please circle what you think the correct infection rate is for each WMU. We want to find out what you think the infection rates are. There is no right or wrong answer. We provide 4 categories of severity based upon the number of infected deer per 100 in each WMU. The infection rates are explained in the table below.

Infection Rate	Infected Deer per 100
None	0
Low	1 to 5
Medium	6 to 10
High	10 or more
I Don't know	I don't know how many deer are infected.

Please circle what you think the correct infection rate is for CWD in each of the WMUs this past year.					
148	**None**	**Low**	**Medium**	**High**	**I Don't Know**
150	**None**	**Low**	**Medium**	**High**	**I Don't Know**
151	**None**	**Low**	**Medium**	**High**	**I Don't Know**
162	**None**	**Low**	**Medium**	**High**	**I Don't Know**
163	**None**	**Low**	**Medium**	**High**	**I Don't Know**
200	**None**	**Low**	**Medium**	**High**	**I Don't Know**
234	**None**	**Low**	**Medium**	**High**	**I Don't Know**
236	**None**	**Low**	**Medium**	**High**	**I Don't Know**
256	**None**	**Low**	**Medium**	**High**	**I Don't Know**
500	**None**	**Low**	**Medium**	**High**	**I Don't Know**

In this section we are trying to understand what you would do if hunting conditions changed in the areas where you normally hunt. Please read the following instructions carefully then answer the proceeding questions.

In this section, you will be presented with a number of tables. Each table will contain the same WMUs you were asked about in previous questions. Along with the WMUs will be the number of trips you stated as having taken in 2007. Following this will be different scenarios as to whether CWD is present in the area, whether extra tags are being offered for that area, and whether the government is proceeding with active herd culling in the WMU.

You are then asked to decide how many hunting trips you would take to each WMU given the different scenarios. Please treat each scenario as if it was a real situation. Look at the various levels for CWD occurrence, number of extra tags offered, and government culling in the area, then assess exactly how many trips you would take in the next season if these were the actual conditions present in each WMU. Please assume that nothing else will change in those areas other than the conditions presented to you.

This will give you an idea of how widespread the disease is in that WMU. There are 4 categories; none, low, medium, and high.

This is whether or not the government has undertaken a large population reduction, prior to the 2008 hunting season, to help control CWD.

WMU	**Number of trips in 2007**	**Prevalence of CWD**	**Extra tags**	**Active culling in area**	**Number of trips you would take in 2008**
148					
150					
151					
162 More ↓					

This is whether or not extra tags, above what you currently have, will be given to you if the head of your bagged animal is returned for CWD testing.

The infection rates for wild deer herds are reflected in the following rates. They are listed as *number of infected animals in every 100 deer* in the herd.
None – 0 deer infected per 100
Low – 1 to 5 deer infected per 100
Medium – 6 to 10 deer infected per 100
High – Greater than 10 deer infected per 100

Example:

WMU	**Number of trips in 2007**	**Prevalence of CWD**	**Extra tags**	**Active culling in area**	**Number of trips you would take in 2008**
148	1	Low	Yes	No	
150	1	Low	Yes	Yes	
151	0	None	No	No	
162	0	None	No	No	
163	0	Medium	No	No	
200	2	High	No	No	
234	0	Medium	No	Yes	
[illegible]	0	None	No	Yes	
[illegible]	0	None	No	No	
[illegible]	0	High	No	No	
730	0	High	No	No	
Other WMUs	1	Low	No	No	

You will input the number of trips you will take in 2008 given the scenario for each WMU.

These are the number of trips you previously told us you took to these WMUs.

Scenario 1

WMU	Number of trips in 2007	Prevalence of CWD	Extra tags	Active culling in area	Number of trips you would take in 2008
148		None	No	No	
150		Medium	Yes	Yes	
151		Medium	Yes	Yes	
162		None	No	No	
163		None	No	No	
200		None	No	No	
234		Medium	Yes	Yes	
236		None	No	No	
256		None	No	No	
500		None	No	No	
Other WMUs		None	No	No	

Scenario 2

WMU	Number of trips in 2007	Prevalence of CWD	Extra tags	Active culling in area	Number of trips you would take in 2008
148		Low	Yes	No	
150		Medium	No	No	
151		Medium	Yes	Yes	
162		Low	No	Yes	
163		None	No	No	
200		Low	No	Yes	
234		Medium	Yes	No	
236		Low	Yes	No	
256		None	No	No	
500		Low	Yes	Yes	
Other WMUs		None	No	Yes	

3rd Scenario

WMU	Number of trips in 2007	Prevalence of CWD	Extra tags	Active culling in area	Number of trips you would take in 2008
148		Medium	Yes	Yes	
150		Medium	No	Yes	
151		Medium	No	No	
162		None	No	No	
163		None	Yes	Yes	
200		None	Yes	Yes	
234		Medium	No	No	
236		None	Yes	Yes	
256		None	Yes	No	
500		Low	No	No	
Other WMUs		None	No	Yes	

The following are some statements regarding hunter behaviour and CWD. Please indicate using the scale of 1 (Strongly Disagree) to 5 (Strongly Agree) your agreement with the statement.

	Strongly Disagree		Indifferent		Strongly Agree
I have changed where I normally hunt because of CWD.	**1**	**2**	**3**	**4**	**5**
I no longer consume deer meat because of CWD.	**1**	**2**	**3**	**4**	**5**
CWD has had no affect on my hunting activities.	**1**	**2**	**3**	**4**	**5**
I have not hunted in a CWD affected area.	**1**	**2**	**3**	**4**	**5**
I have changed which species I normally hunt due to CWD.	**1**	**2**	**3**	**4**	**5**
I regularly submit my deer heads for CWD testing to Fish and Wildlife.	**1**	**2**	**3**	**4**	**5**
If the frequency of CWD was decreased, I would increase my hunting in Alberta.	**1**	**2**	**3**	**4**	**5**
CWD has affected my enjoyment of hunting deer.	**1**	**2**	**3**	**4**	**5**
If CWD were found in the WMU where I received a trophy buck tag, I would still hunt in that WMU.	**1**	**2**	**3**	**4**	**5**
I think baiting and the use of scents helps to promote the spread of CWD.	**1**	**2**	**3**	**4**	**5**
I think game farms contribute to the spread of CWD.	**1**	**2**	**3**	**4**	**5**
I think hunters should report back to landowners if there was a positive animal found on their land.	**1**	**2**	**3**	**4**	**5**

Please answer the following questions regarding CWD. If the statement is true, please circle the T next to that statement. If the statement is false, please circle the F next to that statement.

The most obvious sign of CWD is significant weight loss over time.	T	F
The only definite test for CWD occurs by testing the brain and lymph nodes after death.	T	F
The largest concentration of CWD in North America is in Wyoming.	T	F
Decreasing the density of the herds is one way to combat CWD.	T	F
The infection protein (the prion) is resistant against normal disinfecting procedures.	T	F
CWD been found in the west of Alberta, along the border with B.C.	T	F

Now we would like to ask some questions about you. The next set of questions are to help us find similarities between different groups of people and to identify trends in the hunting population. Please be ensured that your responses will be kept strictly confidential.

Are you:

Male   Female

Are you a member of any of the following organizations?

a) Alberta Professional Outfitter Society
b) Alberta Conservation Association
c) Alberta Fish and Game Association
d) Sierra Club
e) Canadian Parks and Wilderness Society
f) Nature Conservancy of Canada
g) Alberta Federation of Naturalists

How old are you? _________ years old

What is the highest level of schooling you have completed? Please circle the correct answer.

Some high school or less
High school diploma
Some university, college, or technical school
Technical school graduate
University/College graduate
Some graduate school
Graduate degree

Please indicate your household income before taxes in 2007?

Less than 10 000	50 000 to 59 999
10 000 to 19 999	60 000 to 79 999
20 000 to 29 999	80 000 to 99 999
30 000 to 39 999	100 000 to 149 999
40 000 to 49 999	greater than 150 000

How many people contribute to your household income? _________

Please indicate, by circling the most appropriate choice, where you currently live.

Large urban setting (100 000 people or more)
Small urban setting (20 000 to 99 999 people)
Town or village (1 000 to 19 999 people)
Rural setting (999 people or less)

Are there any children under 12 in your household? Yes No
If yes, how many? ________

What are the first three digits of your postal code? _____________

In order to continue our research in this area, we would like to contact you again, in approximately one year, to request information and your opinions on the 2008 hunting season. We would also like to be able to link your answers from this survey to the next one. In order to do this, your contact information would be recorded along with your answers. This would reduce the anonymity of your answers although they would still be kept strictly confidential. Your information will not be given out or shared in any way. The only person with access to your information will be the researcher contacting you next year to ask for your participation in the second part of the survey.

Would you be willing to participate in a similar survey next hunting season?
Yes No

If *yes*, please provide the following information.

Name:
Address:
Town/City:
Postal Code:
Phone number:
E-mail (if applicable):

If you wish to leave comments about the survey or hunting-related issues in it, please use the box below. Your feedback is highly appreciated.

If you would like to learn more about CWD please visit the following websites:
http://www.srd.gov.ab.ca/fishwildlife/livingwith/diseases/chronicwastingdisease.aspx
http://www.cwd-info.org/

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY!
Your responses are very much appreciated!

Appendix B – Descriptive Results from 2007 and 2008

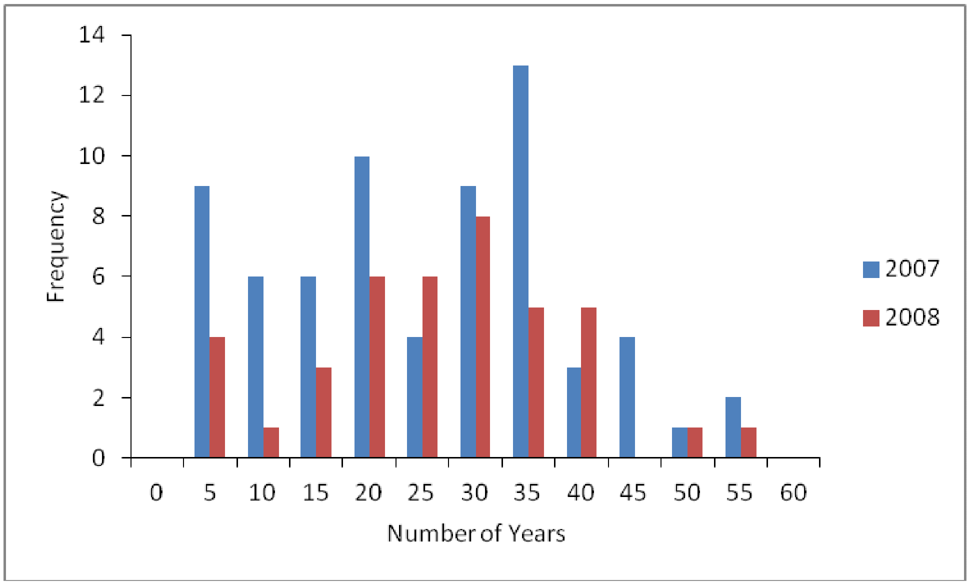


Figure B-1. A histogram representing the number of years the survey respondents previously hunted.

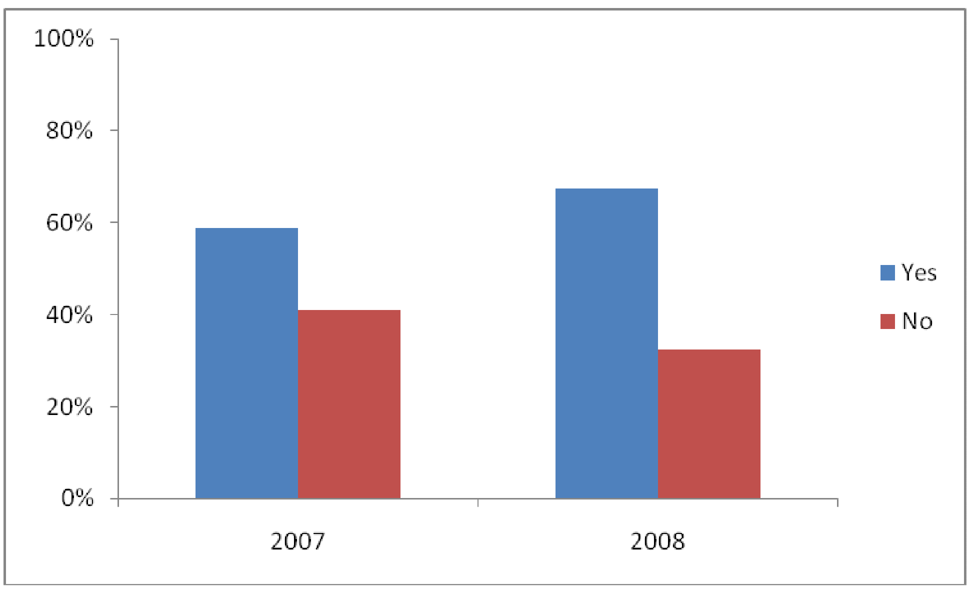


Figure B-2. The percentage of survey respondents who hunted during their childhood.

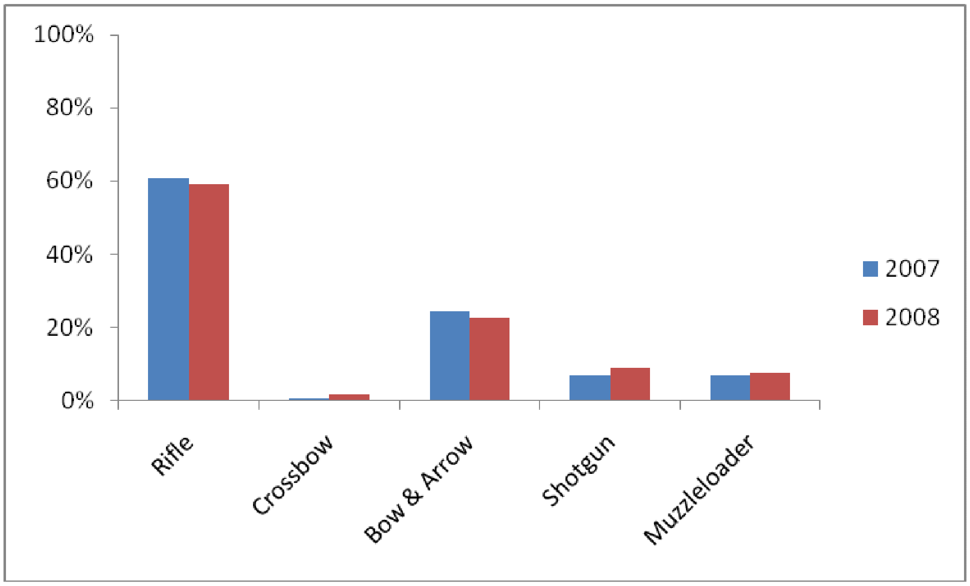


Figure B-3. The percentage of survey respondents that reported using the various weapons during their hunting trips.

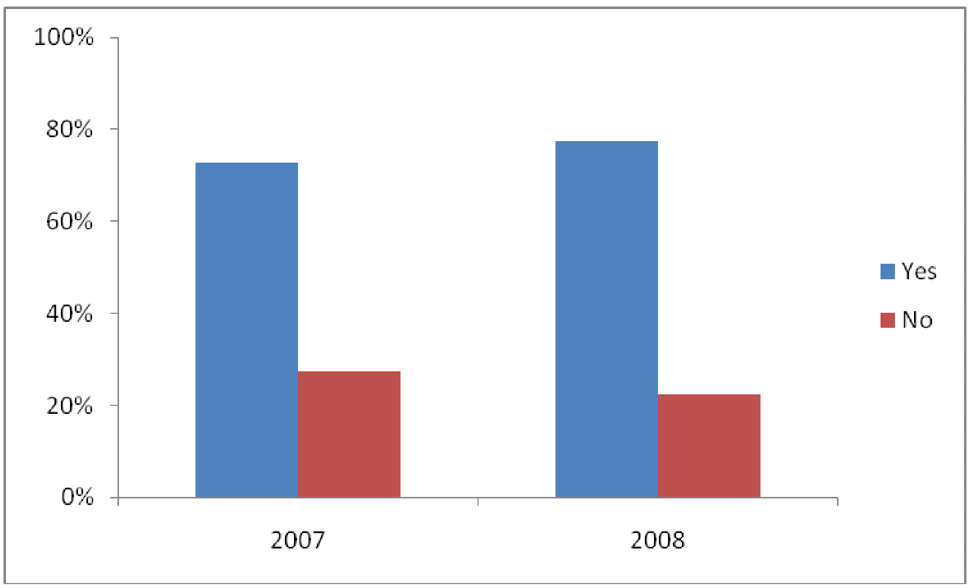


Figure B-4. The percentage of survey respondents that reported to have taken a hunting training course.

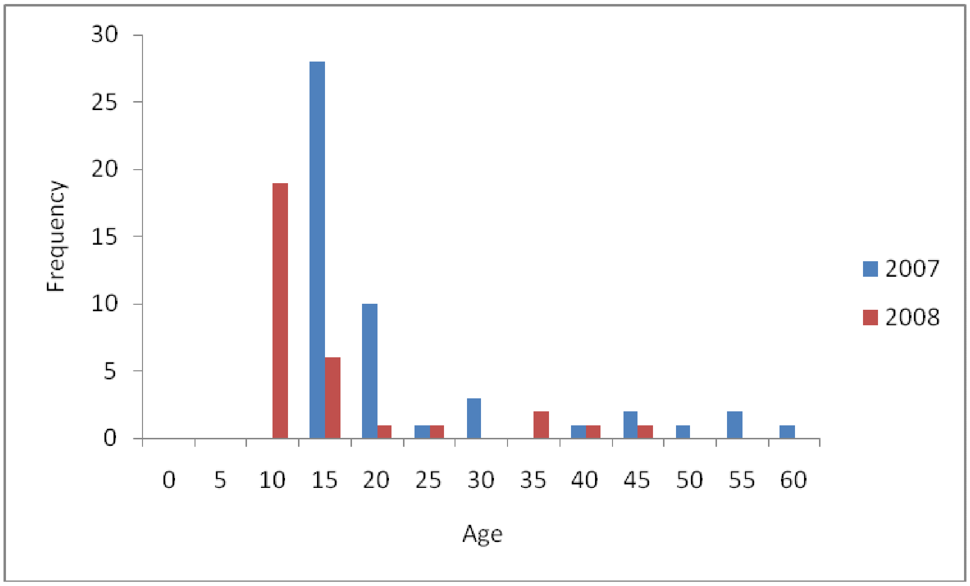


Figure B-5. A histogram of the survey respondents’ age when they reported taking the hunting training course.

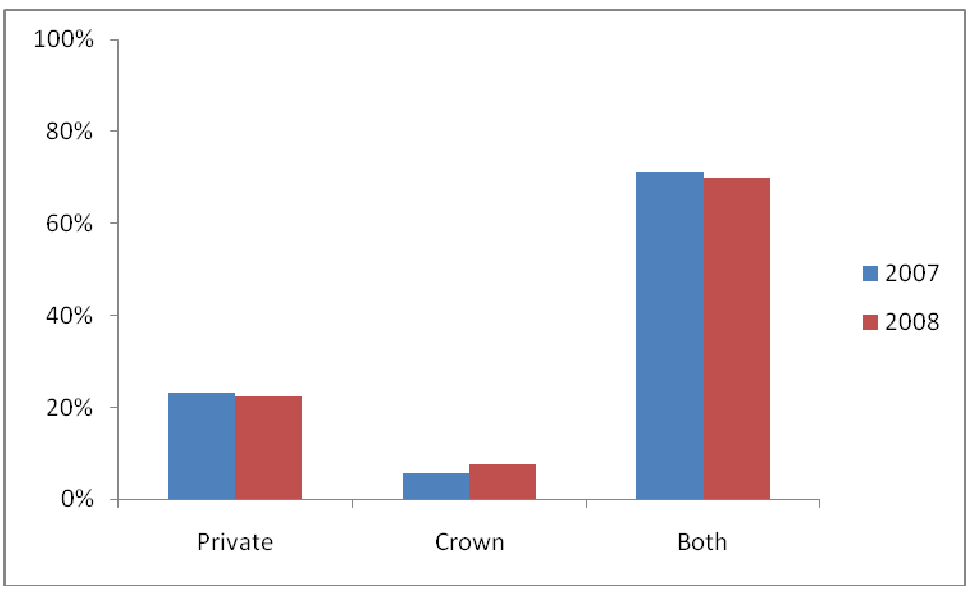


Figure B-6. The reported percentage distribution of type of land hunted on by the survey respondents.

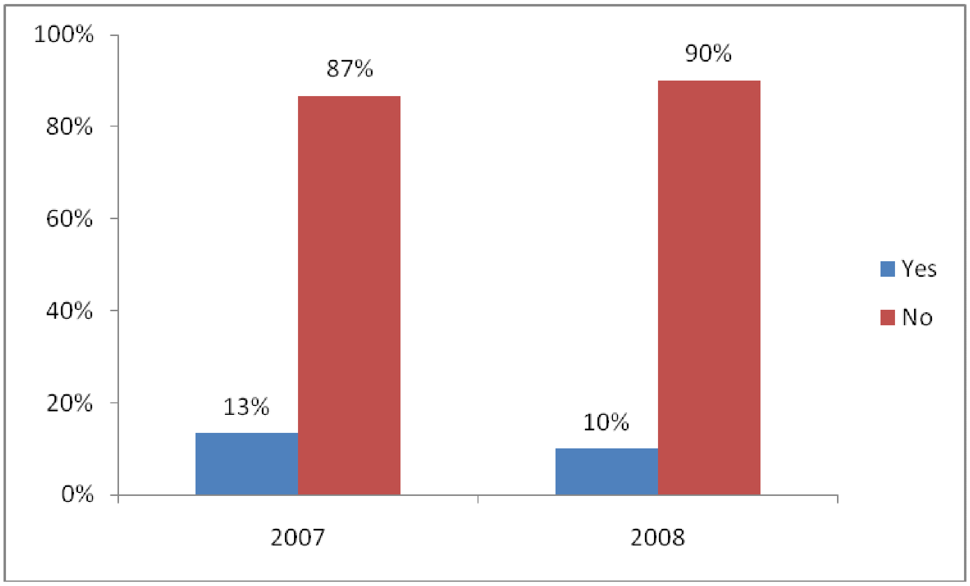


Figure B-7. The percentage of hunters who reported hunting outside of Alberta.

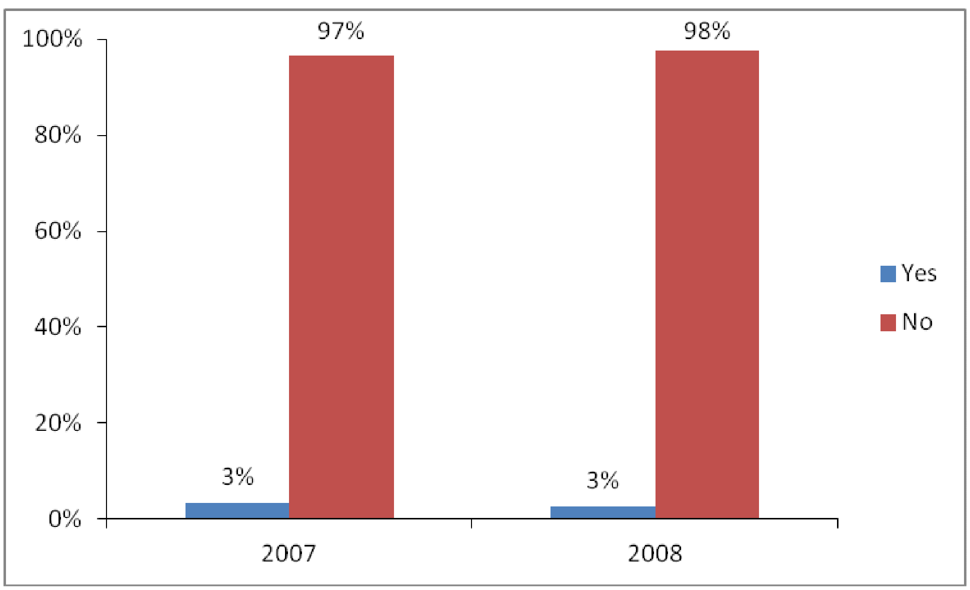


Figure B-8. The percentage of hunters who reported hunting outside of Canada.

The survey asked respondents to rate statements about important qualities of their hunting trips. In 2007 and 2008, those that the majority rated as being very important were seeing deer and interacting with wildlife, having the thrill of hunting/adventure, and just being outside and close to nature. Those that the majority rated as being least important in both years were having good access to the hunting area and close proximity to a cabin or lodge to which I have access. When asked what they would do if deer hunting was not available in their regular area, in both 2007 and 2008, most chose hunt another species in the same area. In 2007, most felt that hunting deer in other areas was the most important alternative; however, in 2008 most felt that hunting another species but in the same area was the most important alternative.

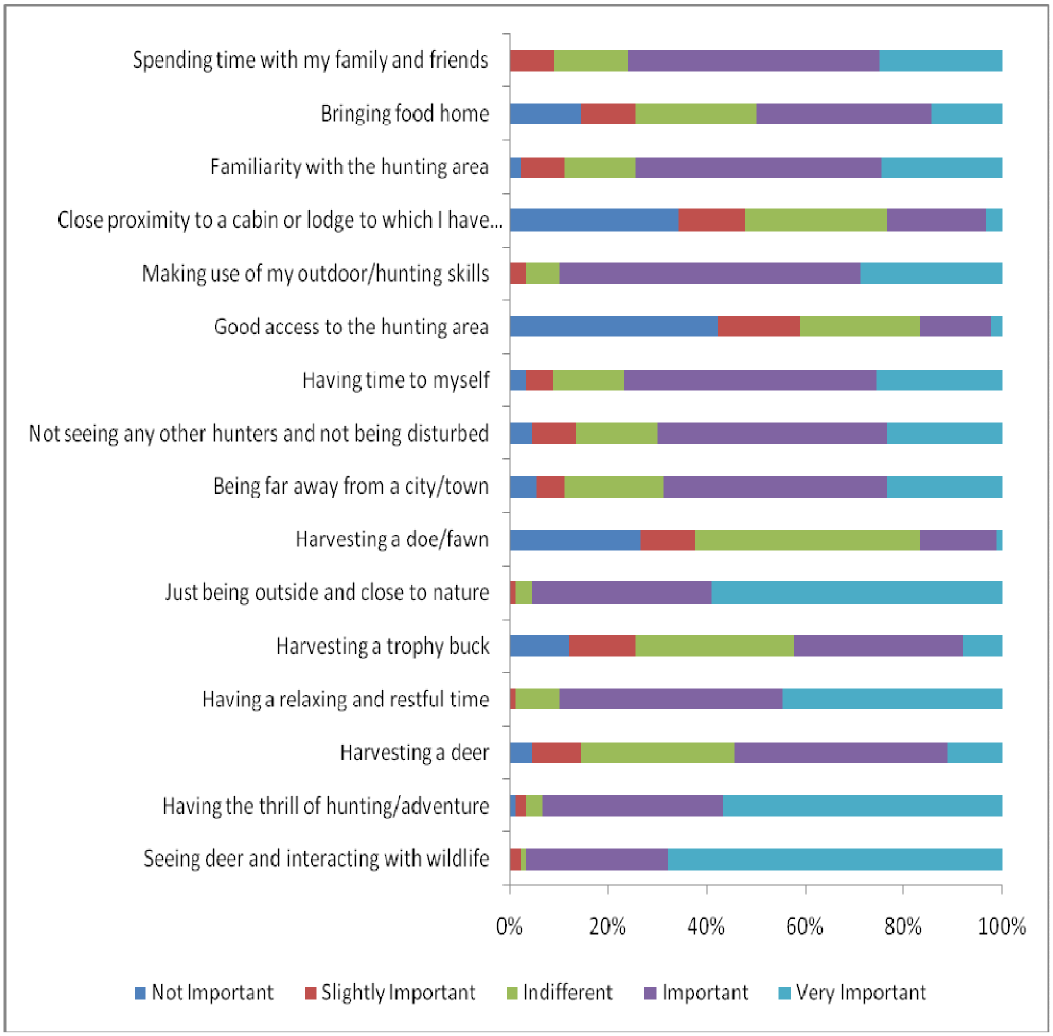


Figure B-9. Bar chart revealing 2007 survey respondents' agreement to statements concerning the importance of hunting qualities to hunters in Alberta.

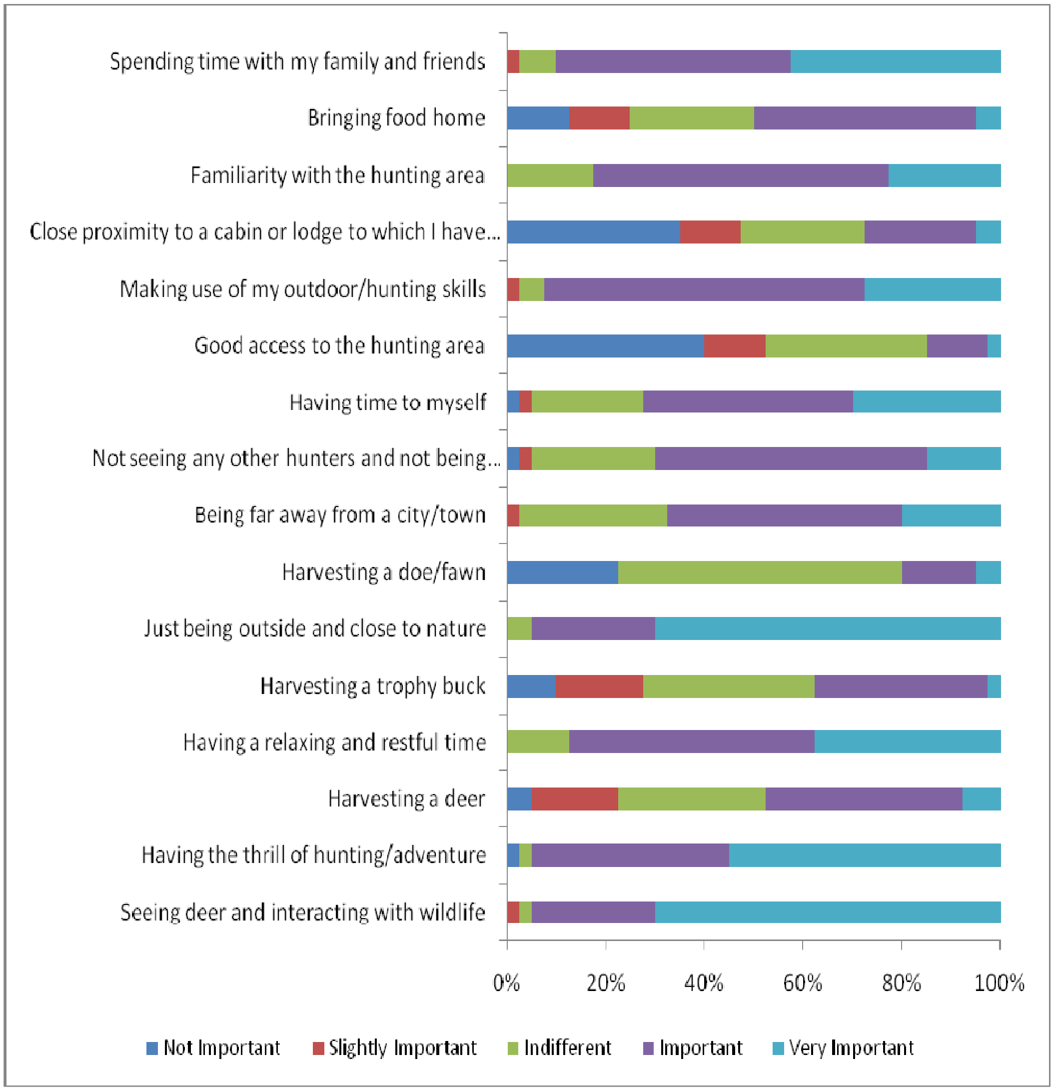


Figure B-10. Bar chart revealing 2008 survey respondents' agreement to statements concerning the importance of hunting qualities to hunters in Alberta.

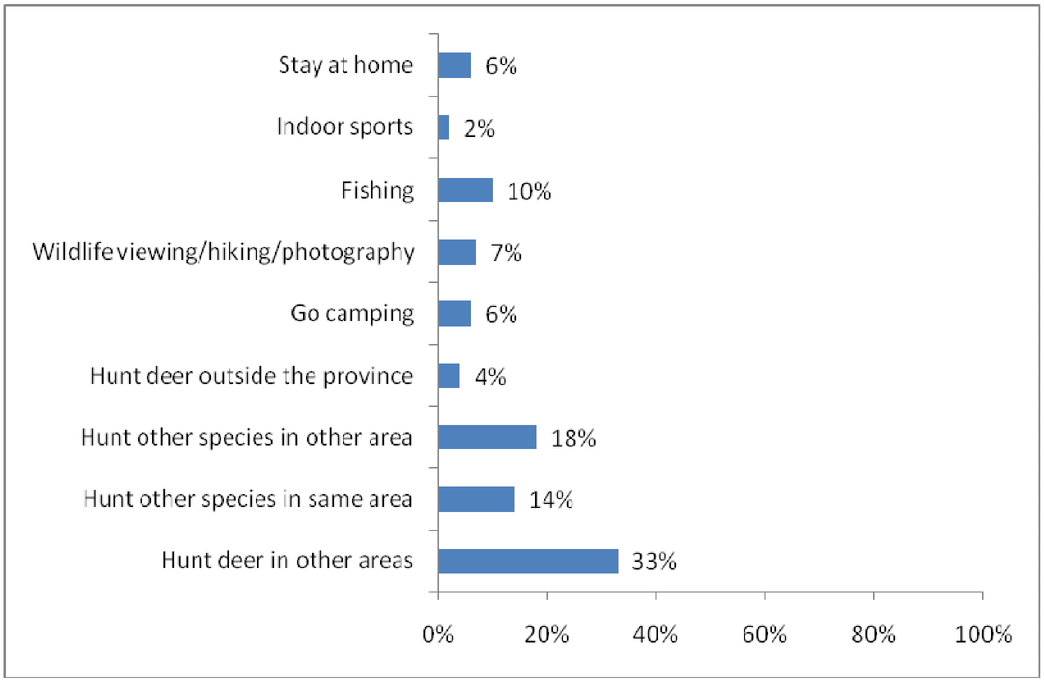


Figure B-11. The percentage of alternatives chosen to hunting deer in a hunter's usual area if that area was not available for 2007.

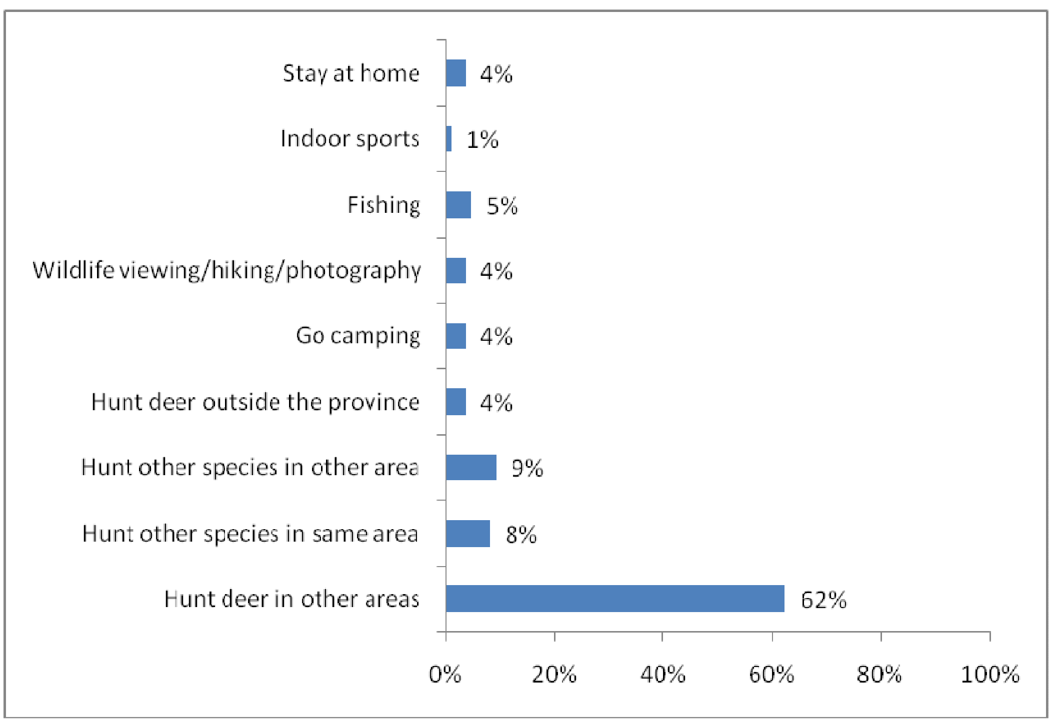


Figure B-12. The percentage of the most important alternative chosen to hunting deer if hunting deer in their usual areas was not available for 2007.

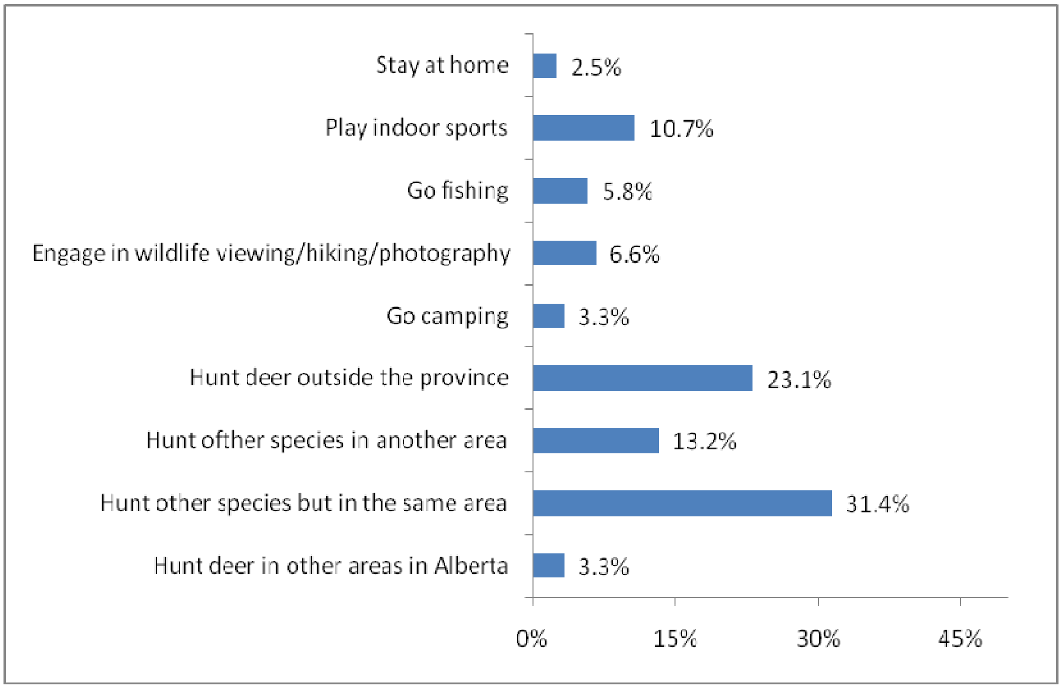


Figure B-13. The percentage of alternatives chosen to hunting deer in a hunter's usual area if that area was not available for 2008.

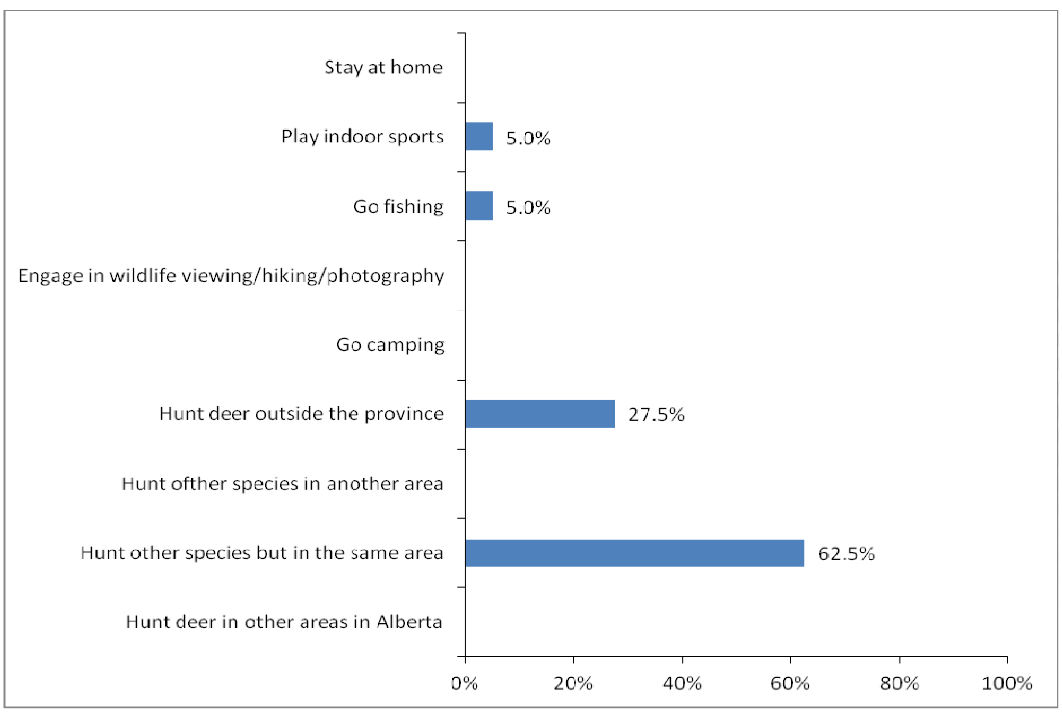


Figure B-14. The percentage of the most important alternative chosen to hunting deer if hunting deer in their usual areas was not available for 2008.

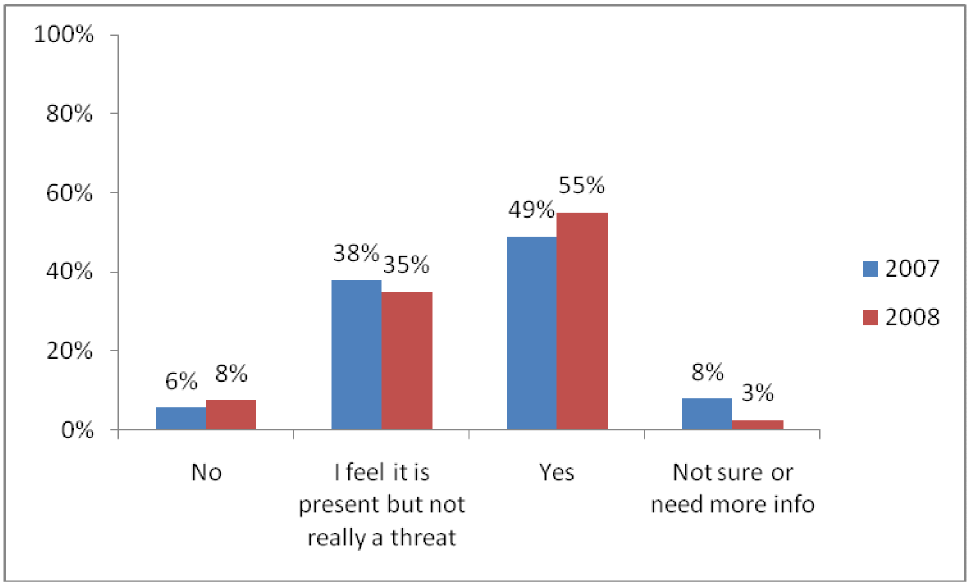


Figure B-15. Percentage of hunters' responses towards the statement "CWD is a threat to wildlife."

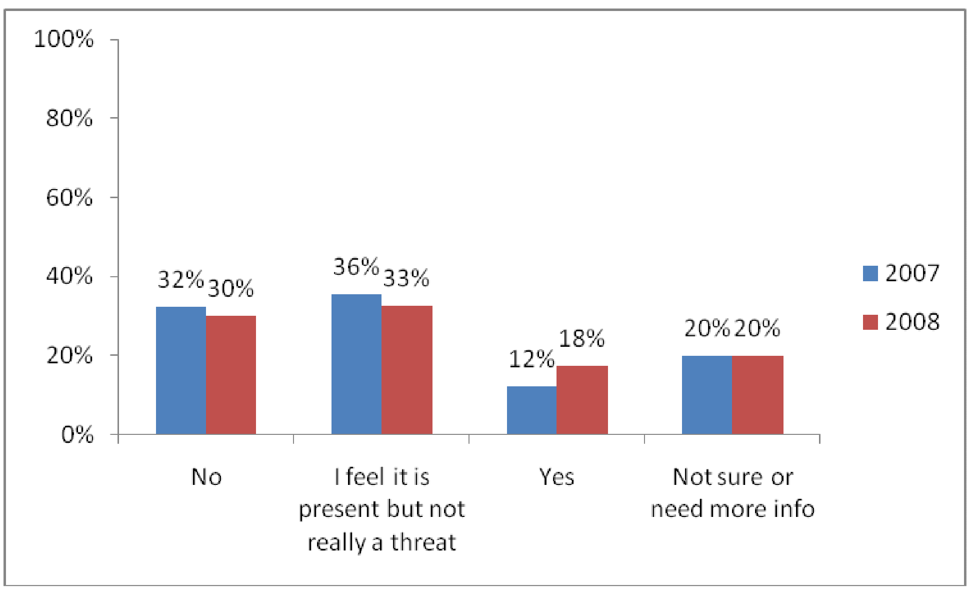


Figure B-16. Percentage of hunters' responses towards the statement "CWD is a threat to human health."

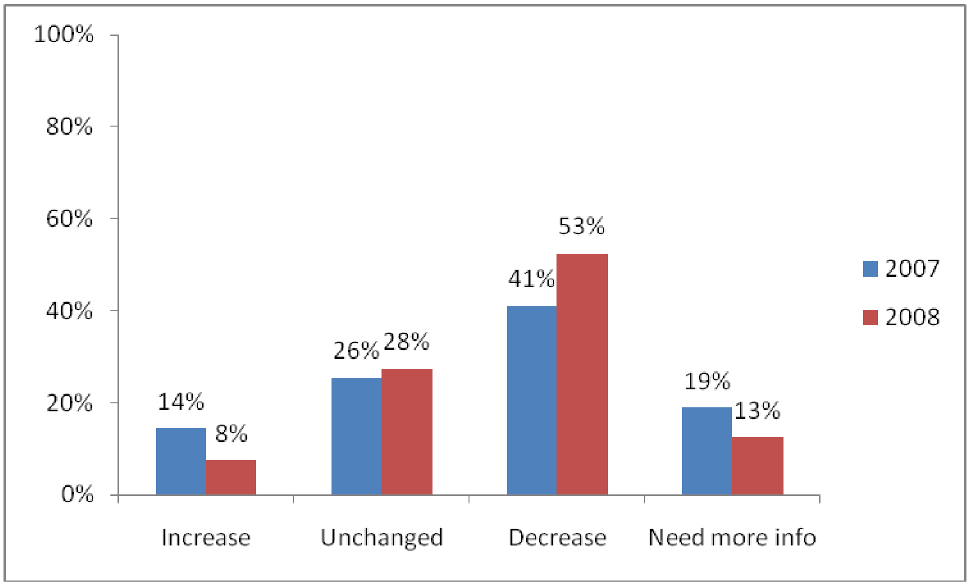


Figure B-17. Hunters' perceptions of how CWD will affect hunting when asked the direct question of how they think hunting will be affected.

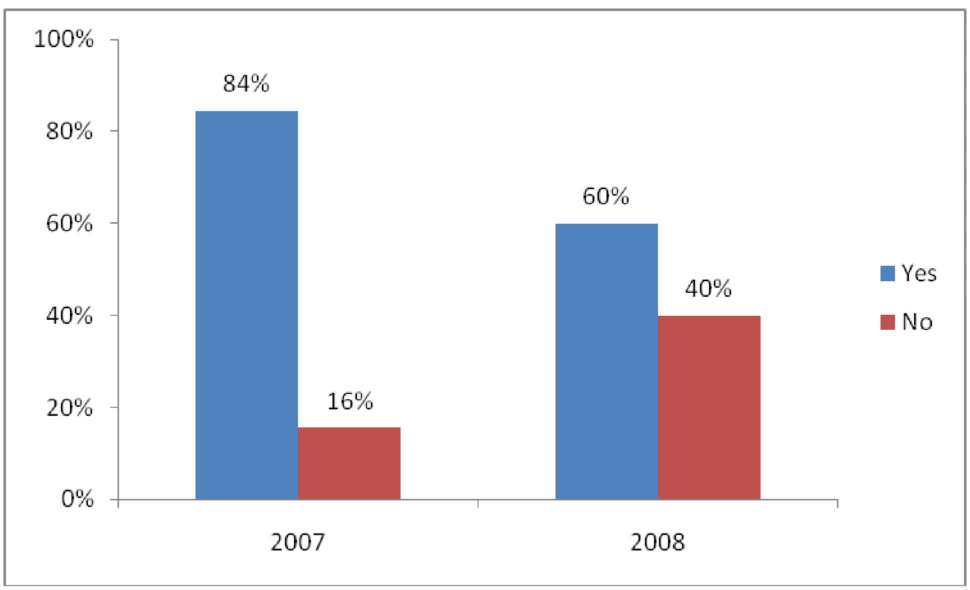
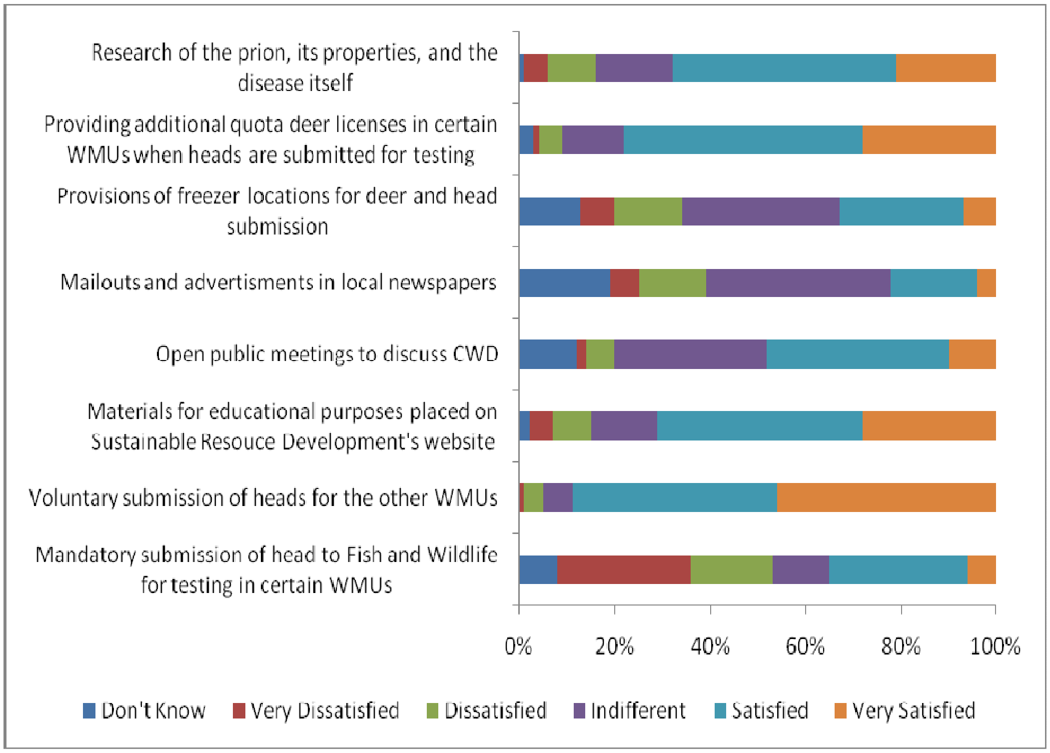


Figure B-18. Hunters' willingness to participate in an extended hunting season as an alternative CWD management tool.

Next, the survey asked qualitative questions regarding satisfaction with the current management policies. While mandatory submission of heads for testing to Fish and Wildlife had mixed reviews in 2007, respondents in 2008 were more satisfied with mandatory submission of heads for testing. Voluntary submission of heads from outside of the study area was found to be very satisfactory for respondents in 2007 but somewhat moderately satisfactory to respondents in 2008. In 2007 there was mixed satisfaction regarding the provision and location of freezers for the deer head submission, while it was overall satisfactory in 2008. While in 2007 CWD education materials on the internet were found to be satisfactory; however in 2008 there was notably less satisfaction. Most respondents in 2007 were satisfied or indifferent regarding town hall meetings discussing CWD. In 2008 more respondents were indifferent concerning town hall meetings to discuss CWD. Respondents in both 2007 and 2008 were largely indifferent or didn't know about mail-outs and information in local newspapers. Most of the respondents in 2007 and 2008 were from urban areas which are not the target area for this policy, so it is not surprising that most of the respondents were indifferent or didn't know.

Respondents in 2007 were largely satisfied to very satisfied with the provision of extra tags and research related to CWD. Respondents in 2008 were less satisfied and were more indifferent with research relating to CWD and were also less satisfied, more indifferent, and didn't know when it came to the provision of extra tags. When respondents were asked how easy it was to find information on the previously mentioned programs, most respondents in 2007 were indifferent or agreed that it was quite easy to find information, while in 2008 most respondents agreed or strongly agreed.



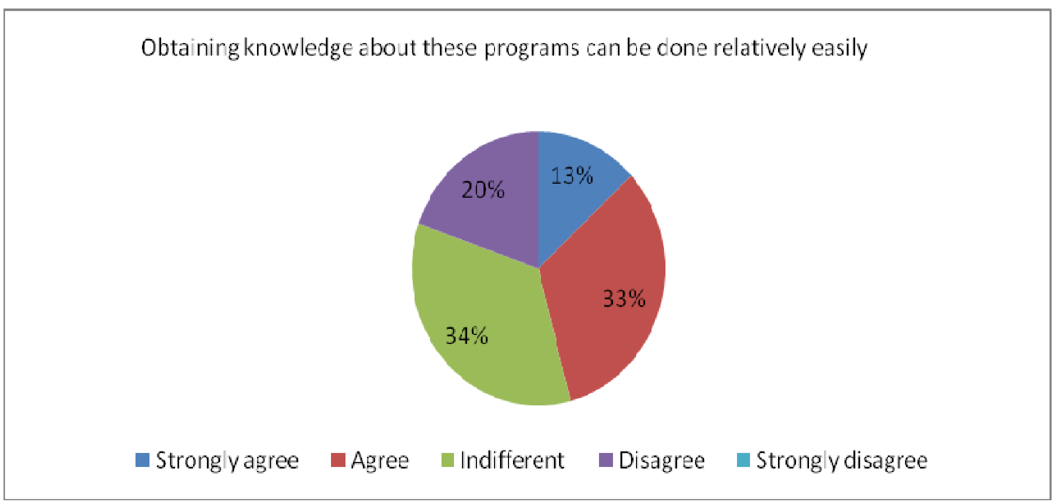
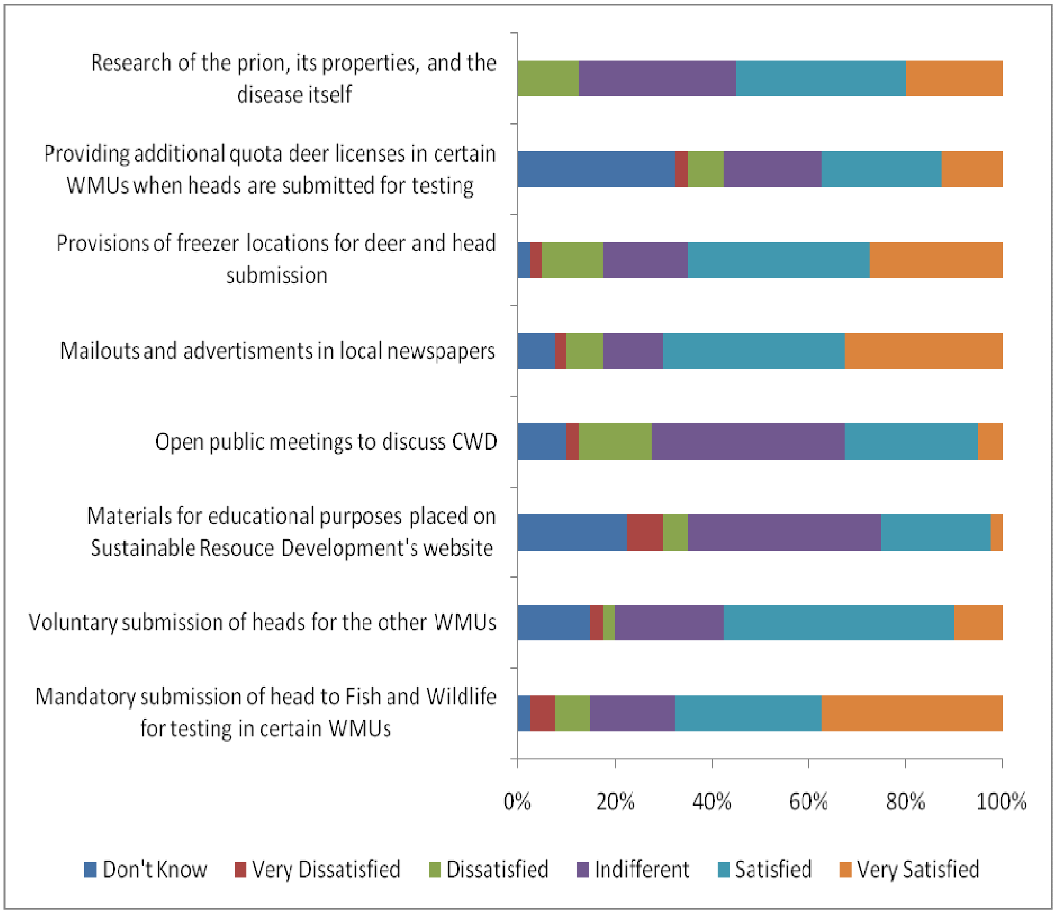


Figure B-19. 2007 responses to statements addressing hunter satisfaction with programs in place to address CWD issues.



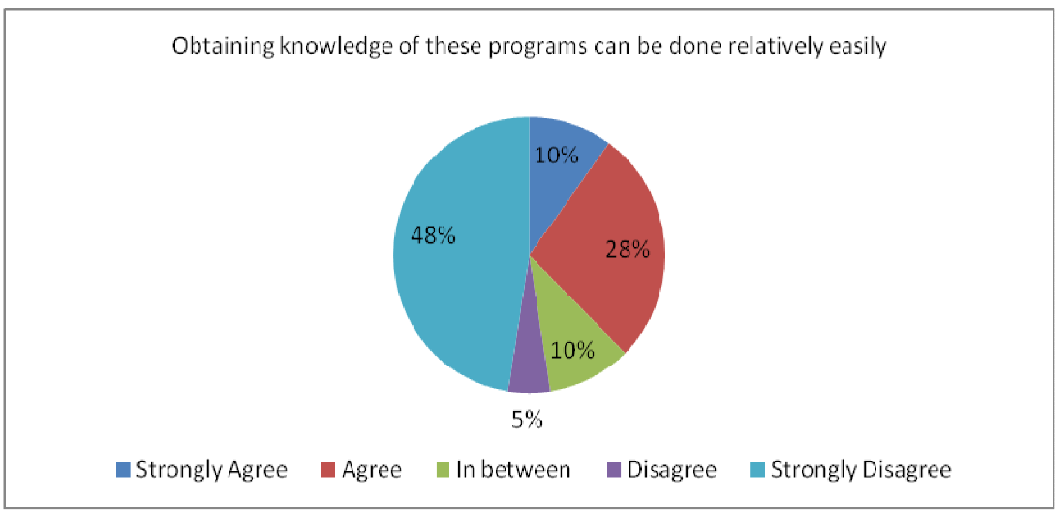


Figure B-20. 2008 responses to statements addressing hunter satisfaction with programs in place to address CWD issues.

To identify hunter perceptions about CWD, they were asked to identify the prevalence level of CWD in each of the WMUs within the study area. For both study years, the correct answer was low for WMUs 150, 151, and 234. I don't know and low prevalence were chosen in most situations by a majority of respondents. Respondents in both study years have not displayed accurate knowledge of CWD prevalence, low prevalence was chosen in a number of WMUs where CWD was not present while medium and high prevalence were chosen by a few respondents in almost every scenario.

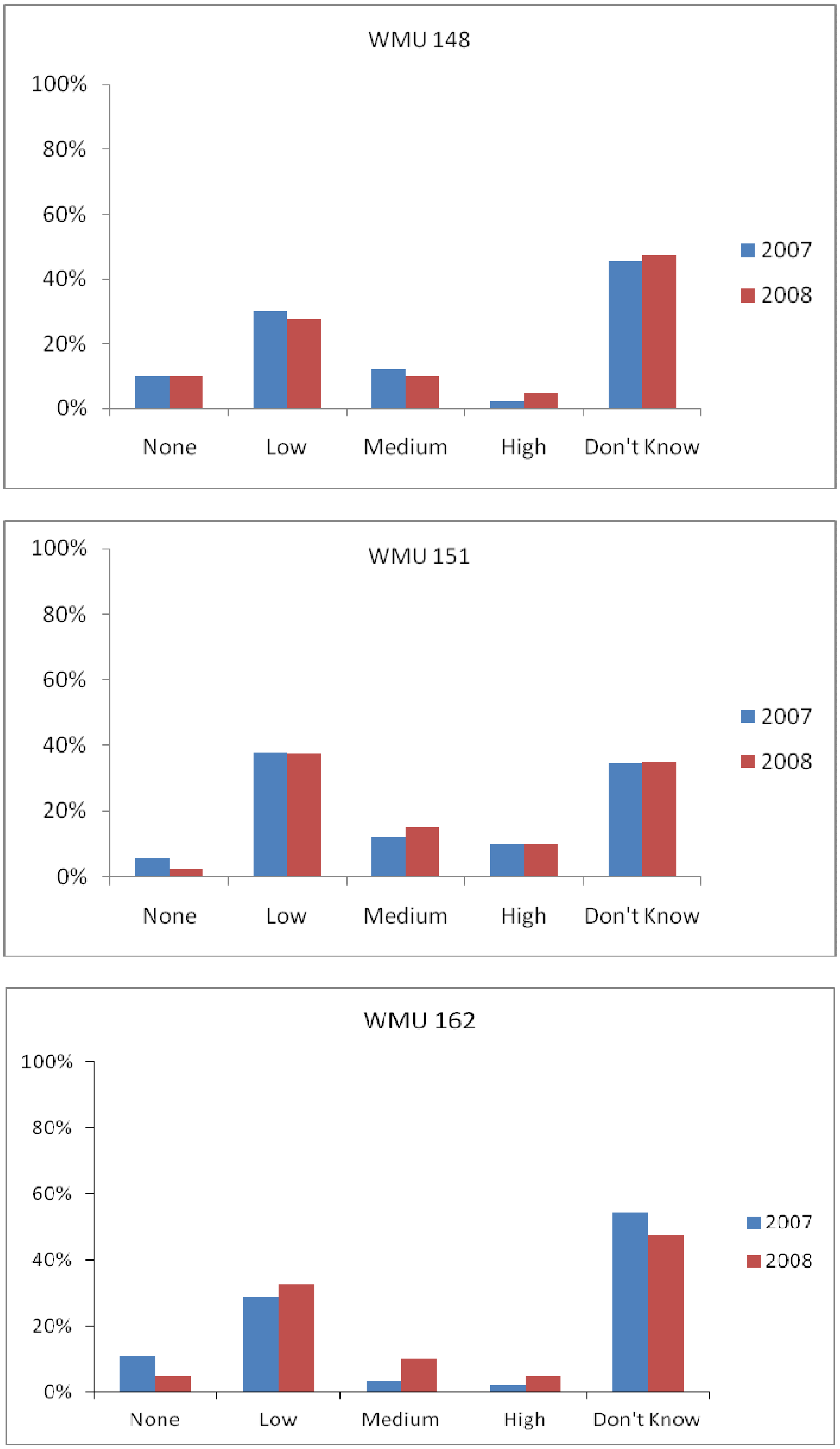


Figure B-21. Hunters' CWD prevalence predictions for each of the Wildlife Management Units (WMUs) within the study area for 2007 and 2008.

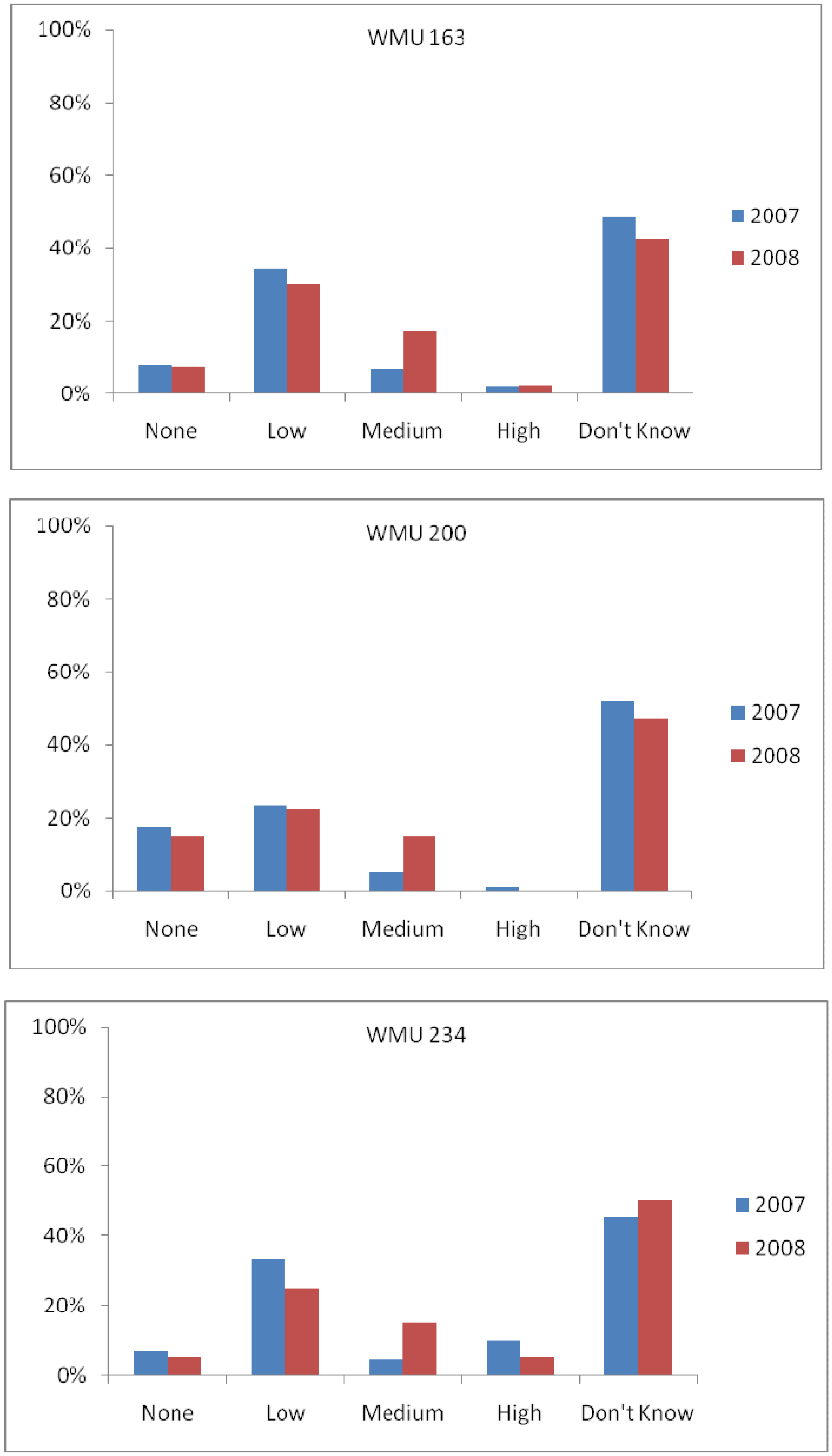
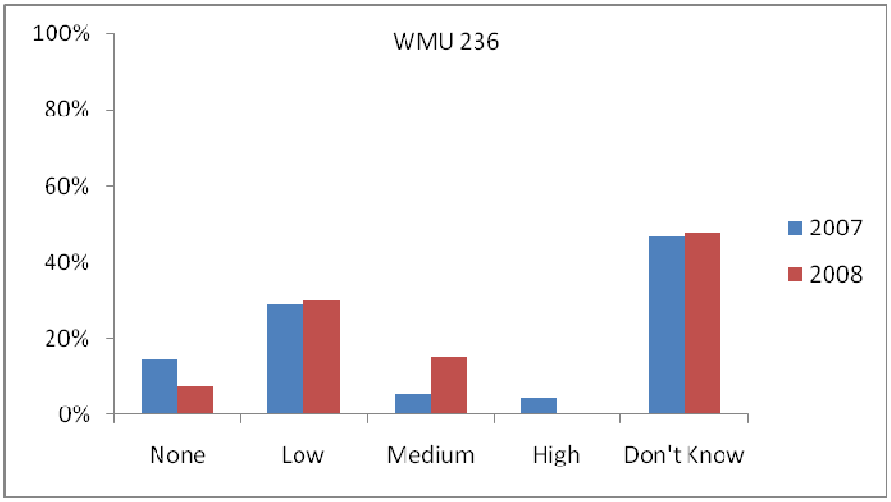
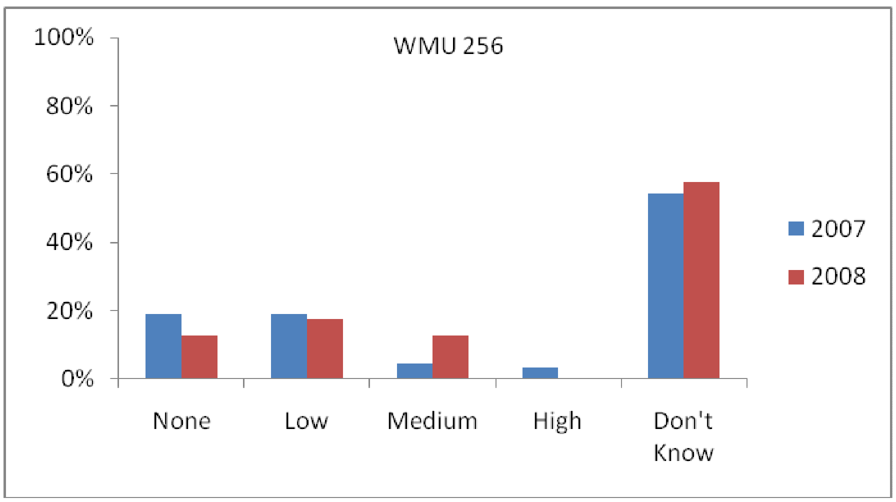


Figure B-21. Hunters' CWD prevalence predictions for each of the Wildlife Management Units (WMUs) within the study area for 2007 and 2008 (con't).





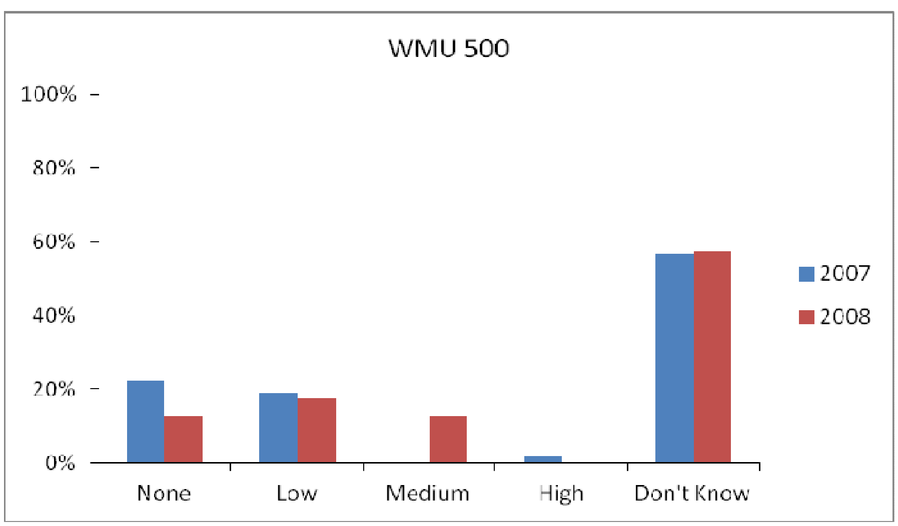


Figure B-21. Hunters' CWD prevalence predictions for each of the Wildlife Management Units (WMUs) within the study area for 2007 and 2008 (con't).

A direct behaviour question asking respondents to rate their level of agreement was asked regarding CWD at the end of the survey. In both 2007 and 2008 most hunters disagreed or strongly disagreed that they changed where they normally hunt due to CWD. While over 90% of respondents in 2007 disagreed or strongly disagreed that they no longer consume deer meat because of CWD, in 2008 42.5 agreed or strongly agreed that they no longer consume deer meat because of CWD. This shows a striking change in behaviour from respondents in 2007 to 2008 in the presence of CWD and deer hunting.

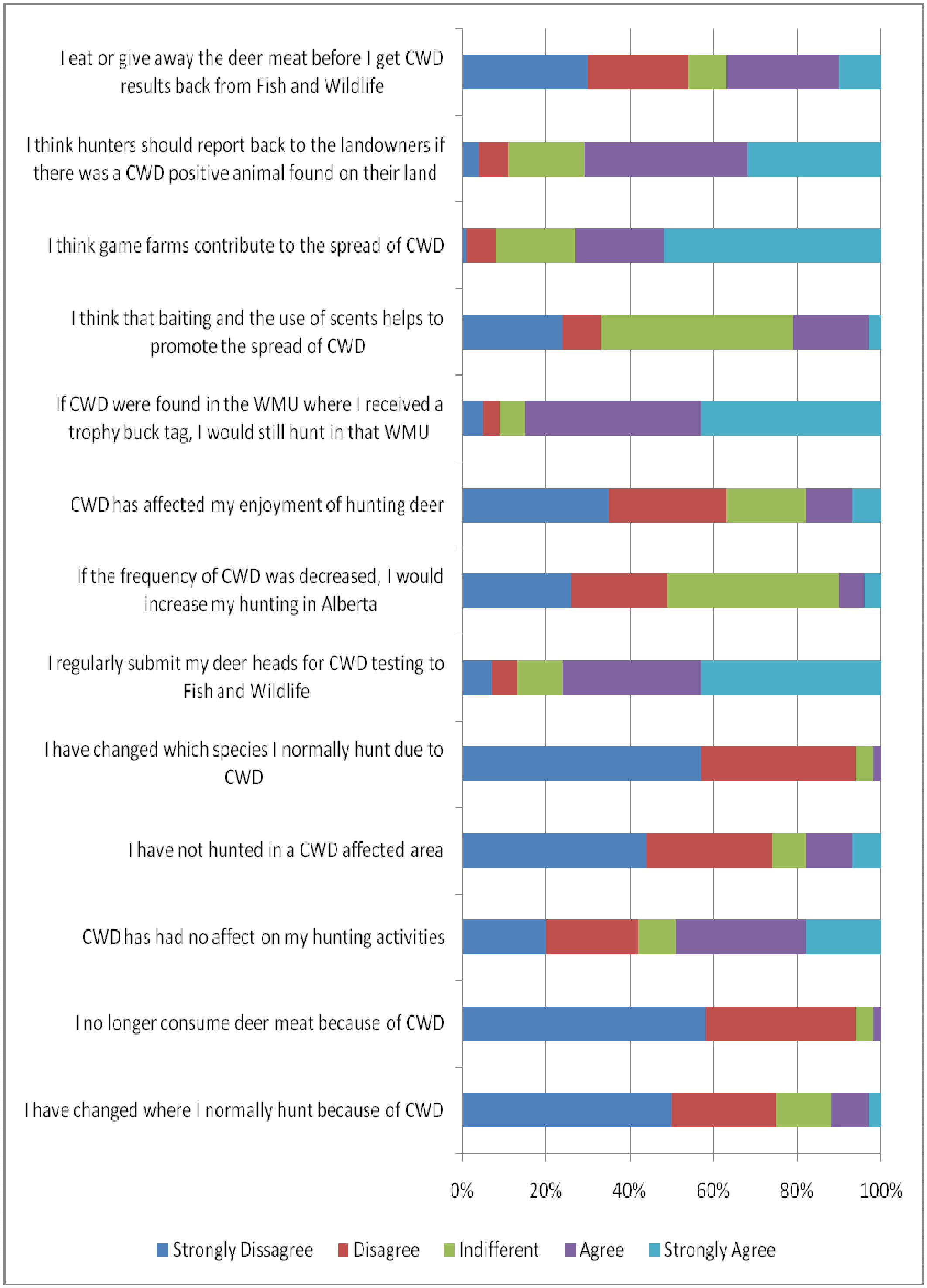


Figure B-22. 2007 hunters' responses to whether or not they agree with certain CWD behavioural impact statements.

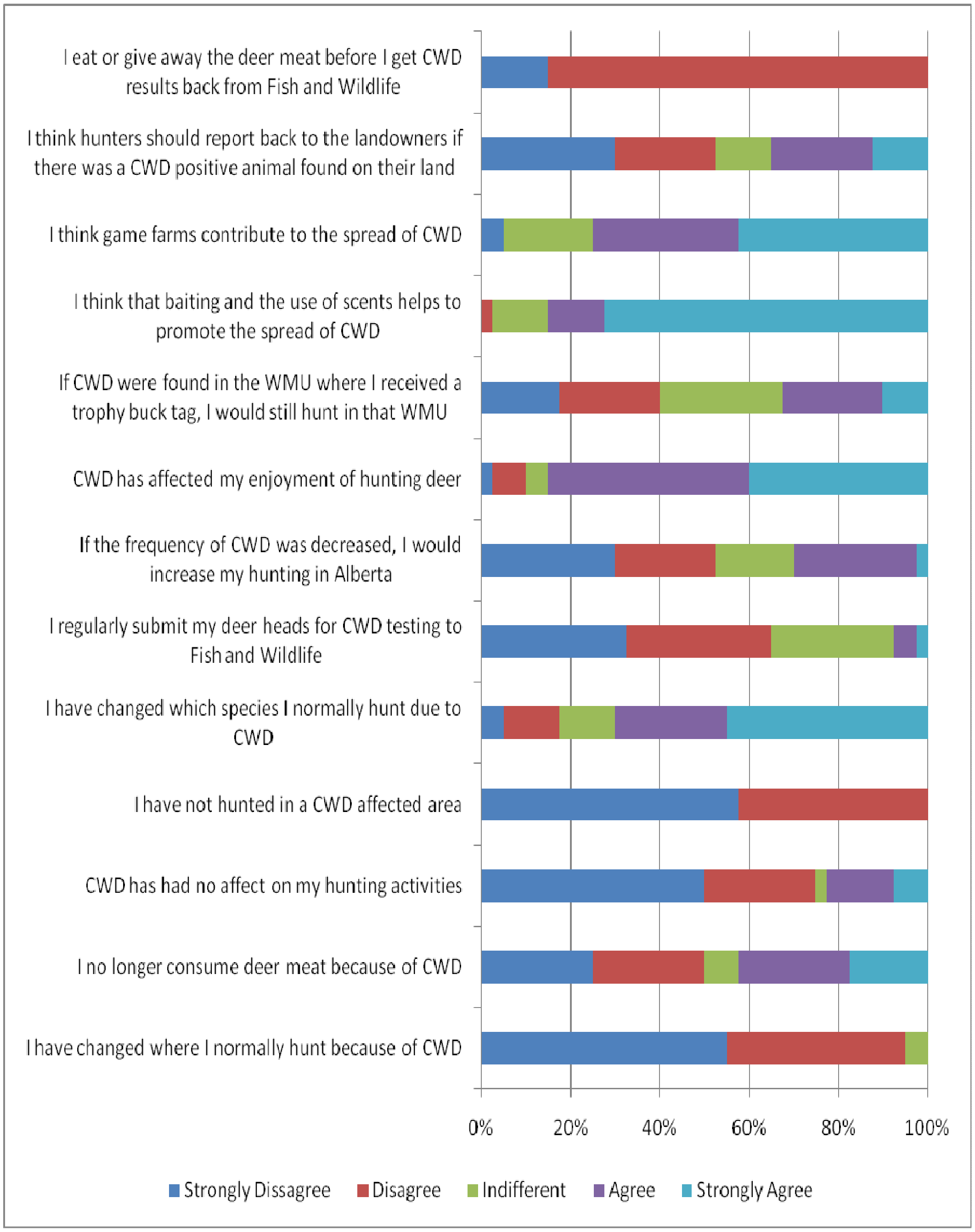


Figure B-22. 2008 hunters' responses to whether or not they agree with certain CWD behavioural impact statements (con't).

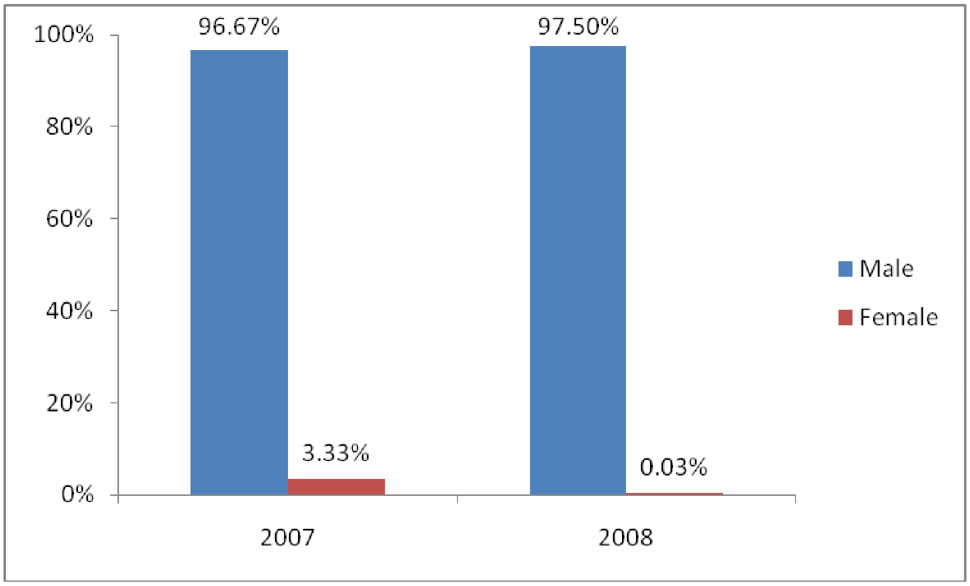


Figure B-23. The proportion of the gender of hunters who responded to the survey.

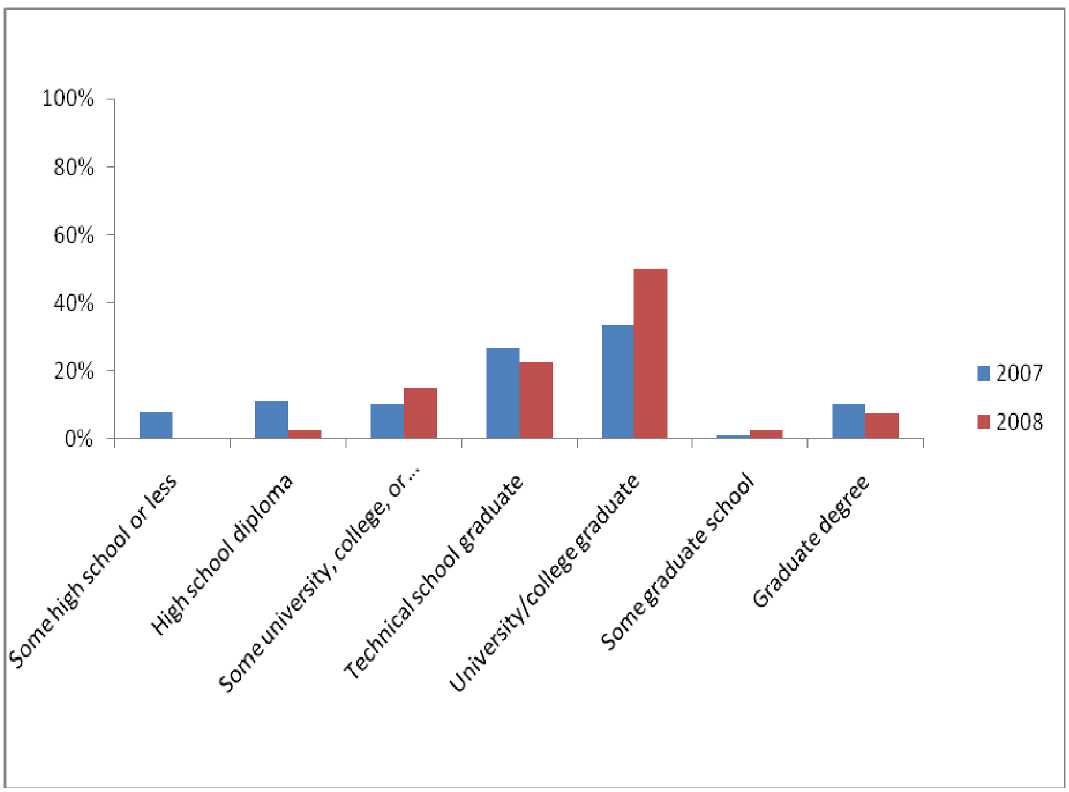


Figure B-24. A histogram of the highest level of education of hunters who responded to the survey.

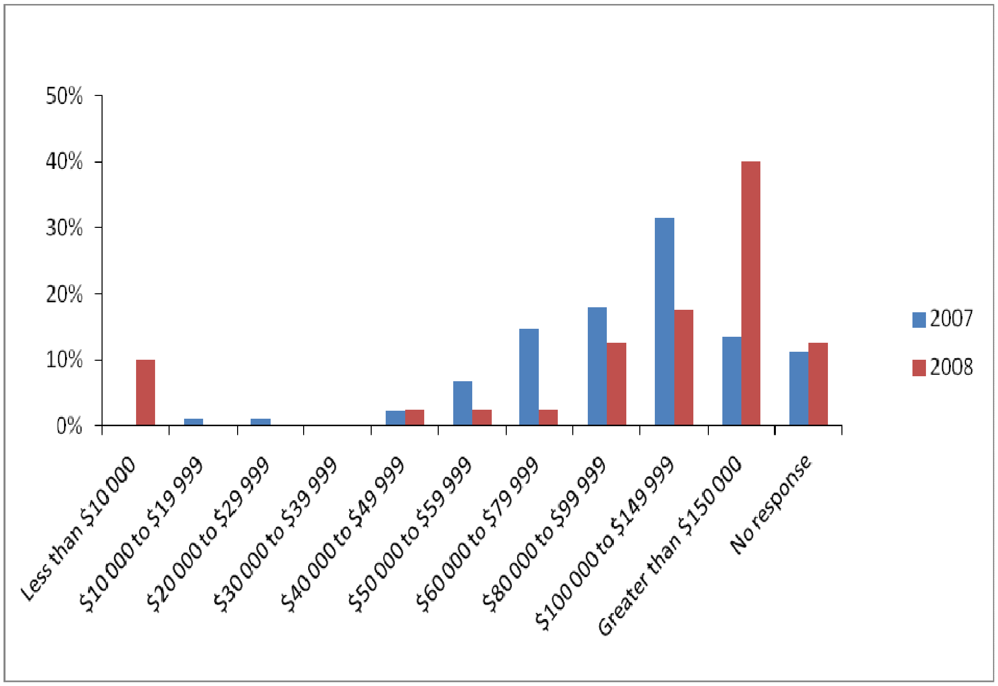


Figure B-25. A histogram of reported household income of hunters who responded to the survey.

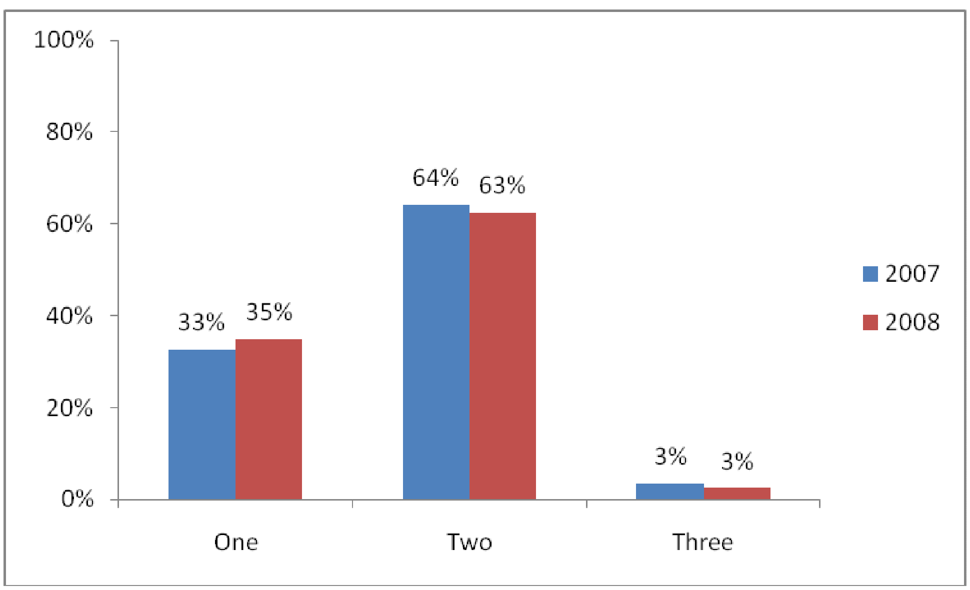


Figure B-26. The number of people reportedly contributing to household income for hunters who responded to the survey.

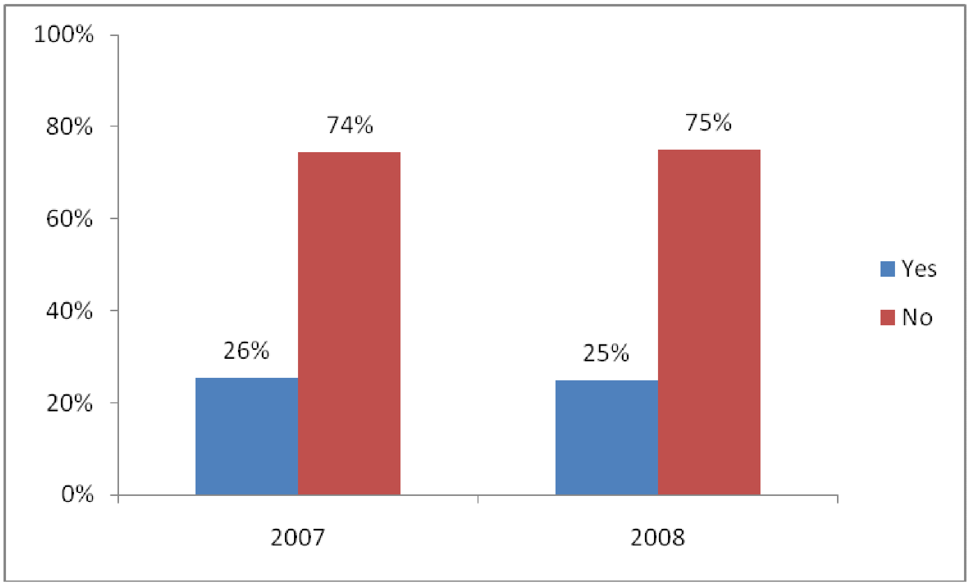


Figure B-27. The percentage of households with children under the age of 12 who responded to the survey.

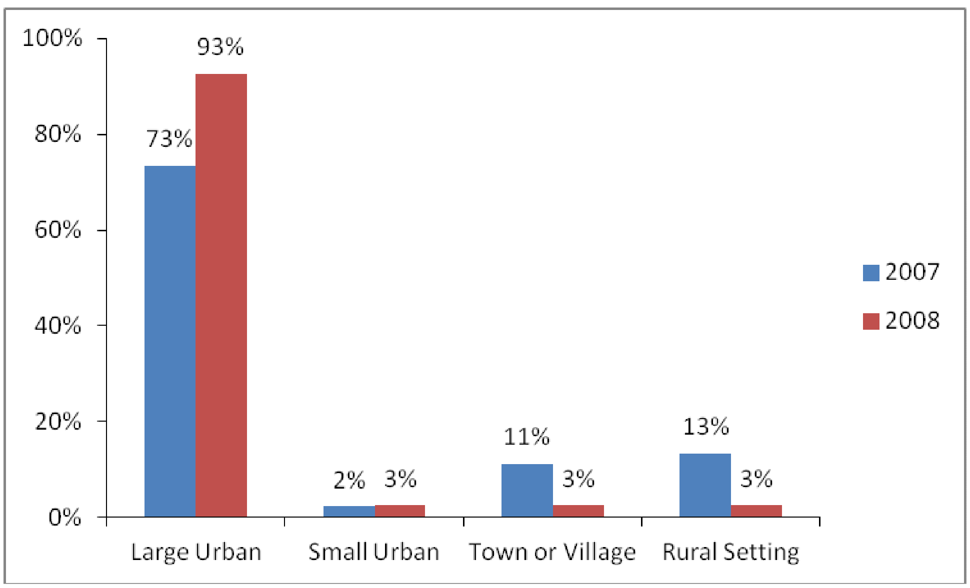


Figure B-28. The percentages representing the proportion of people residing in urban or rural areas who responded to the survey.